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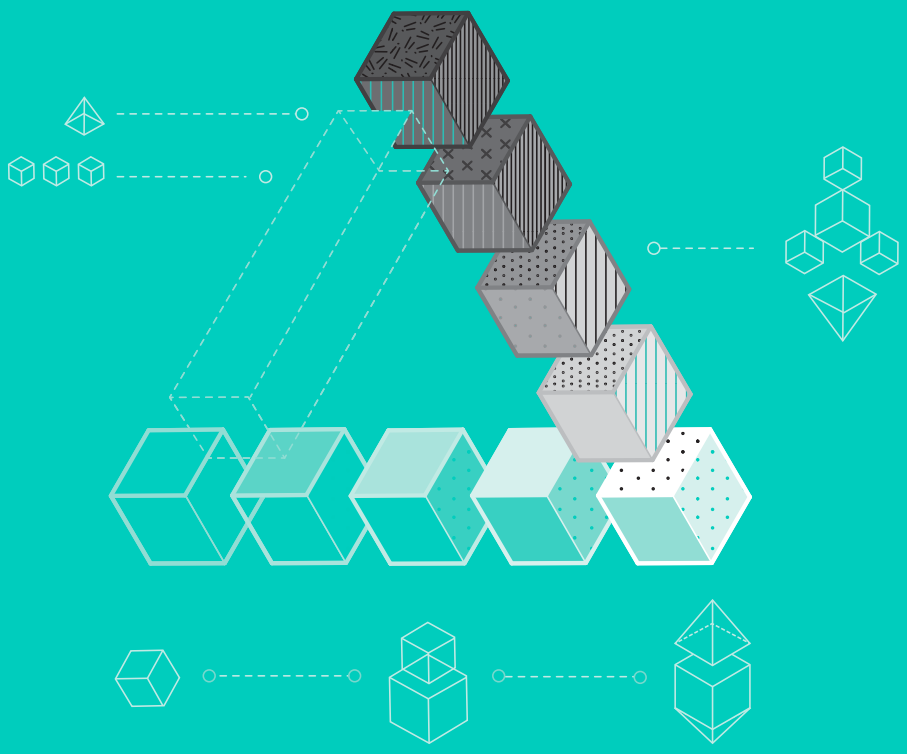
DESIGN RESEARCH JOURNAL: ISSUE 06



designing wisdom

PROSPECTS, PRACTICES & PROVOCATIONS

EMILY CARR UNIVERSITY OF ART + DESIGN

2015

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CURRENT IS PUBLISHED ANNUALLY.

CURRENT@ECUAD.CA

PRINTER
Hemlock Printers Ltd.
7050 Buller Avenue
Burnaby, BC
V5J 4S4 Canada

“design wisdom is a fabric that emerges from the intersection of scientific and designerly ways of knowing and doing.”

Elizabeth B.-N. Sanders

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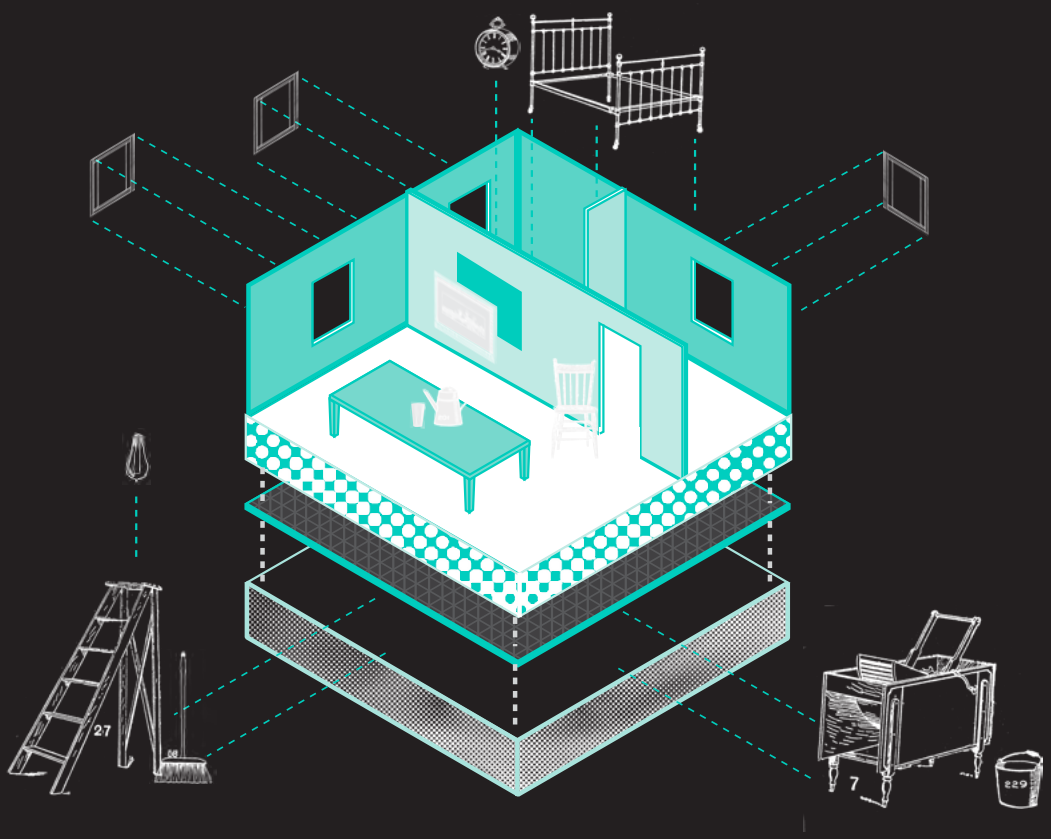

anonymity & authenticity:

EVERYDAY CANADIAN DESIGN

Bonne Zabolotney

THE HISTORY OF design in Canada is a largely undocumented and undiscussed topic in design studies. Not only do Canadian designers and design academics often overlook their own history in favour of European or American design history, there is little to no study of Canadian design found outside of Canada. While this is problematic in terms of lacking information to construct a "canon" of Canadian designers, it remains even more problematic in identifying and placing importance on a century or more of design that has been produced anonymously. This anonymous design, found in magazines, toys, games, catalogues, and other items used by Canadians everyday throughout the 20th century, profoundly intervened in the daily experience of Canadians.

figure 1. Pages from 1899–1900 Eaton's Catalogue.

EVERYDAY EXPERIENCE IN Canada at the beginning of the 20th century often—if not always—included interaction with the Eaton's mail order catalogue. This catalogue, a formidable paradigm-shifting element in Canadian daily life beginning in 1884, conflated consumerism with concepts of modernism, progress, and the duty of citizens to contribute to their nation's economic well-being. In her book *Retail Nation*, Donica Belisle connects the rise of mass retail enterprise and a new attitude towards consumerism to the early formation of Canada as a modern nation, while emphasizing the progression of innovation through "three realms of the marketplace, namely, production, distribution, and consumption" [1].

If the role that department stores and their catalogues play is academically and historically vital in the nation building history of Canada, why do we downplay the importance of everyday, popular culture, and household items that are often ignored in design histories or taken for granted? Canadian design was, and still remains, an intrinsic aspect in the manufacture, production, distribution, and promotion of these goods on display in department stores and throughout their mail-order catalogues. The cultural influence that Eaton's exerted on Western Canada in particular could not have been accomplished without a large number of product designers, graphic designers and illustrators, architects, and—while they may not have been described as such in their own time—systems designers, who were able to orchestrate and build supply and distribution networks with a very limited rail and roadway system.

ACHIEVING AUTHENTICITY

"Authenticity is to be understood as an inherent quality" [8]. Defining what an authentic and significant moment in Canadian design history might be requires a definition of authenticity as a term, and the context in which we might attribute it. While narratives and anecdotes supplied by those who interacted with the Eaton's catalogue may describe an authentic experience, validation and recognition from academics and designers is necessary to create a unified practice of identifying and sharing information. As Charles Lindhom states, "authenticity gathers people together in collectives that are felt to be real, essential, and vital, providing participants with meaning, unity, and a surpassing sense of belonging" [5]. Along with other academics who have focused on the concept of authenticity, Lindholm references Lionel Trilling who writes that notions of authenticity grew out of concepts of sincerity. Relating authenticity to sincerity is a complicated task, however, because it implies that in order to achieve authenticity we must qualify it through experiential terms, rather than confirm it through a quantifiable—and therefore verifiable—method.

The rise of scientific reasoning in the modern era meant that collected data soon became the prime evidence to confirm perceptions of authenticity, relegating notions of intuition and emotion to irrelevancy. Within this context, Canada emerged from the 19th century as a newly unified nation, emphasizing the importance of production and consumption in modern culture. "Historians have paid substantial attention to some aspects of modernization, especially urbanization, industrialization, and the expansion of

...we are left with the task of piecing together an authentic account of Canadian design through oral histories, inconsistent documentation, and speculation.

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the federal government. Still underexplored, though, are the ways mass merchandising changed Canadian life during this time" [1]. If the modernist values extending from urbanization and industrialization in Canada did indeed influence the way in which we valued and recognized—or in fact, did *not* recognize or value—the cultural contribution made by everyday merchandise found in catalogues, then we are left with the task of piecing together an authentic account of Canadian design through oral histories, inconsistent documentation, and speculation.

In many cases, individual illustrations such as the ones contained in figure 1 may not be significant enough to make an authentic contribution to Canadian design history. There are other ways to evaluate these illustrations, however. We could consider the entire page of illustrations as an inter-dependent body of work. We could place the image—or group of images—within the context of emerging technology. We could evaluate specific items as unique and only available in this catalogue. Finally, we could also place these individual objects within an innovative system (ordering goods through the mail) that not only takes advantage of newly formed supply systems, but plugs into a DIY system that has gone beyond what most contemporary retailers today expect from their consumers. While "authenticity can be ratified by experts who prove provenance and origin, or by the evocation of feelings that are immediate and irrefutable," the concept of authenticity in design history requires an understanding of the cultural context in which the work resides [5]. In figure 2, we can consider this kind of mason jar as an authentic contribution to design history when we take the various kinds of design working together—graphic design (labels), the design of the glass vessel, and the design of the wire and sealing system for the jar—and understand the value of the jar within an early 20th century Canadian culture that relied on the preservation of food throughout various seasons.

ACKNOWLEDGING THE ALTERNATIVES

Very few, if any, design historians have situated the importance of anonymous, or unattributed, Canadian design within the broad landscape of design histories. In Brian Donnelly's article, *Locating Graphic Design History in Canada*, he writes about the importance of Canadian designers relying on an oral tradition in their practices, not only in the form of training and mentorship, but also as a way to compile histories. This does not place the concept of orality in opposition to a written canon of Canadian design, but instead considers it as a contribution to a broad range of methods, capable of expanding our knowledge and understanding of our cultural history.

The uncertainty between authentic/acknowledged design and unacknowledged—and therefore less authentic—design is a continuation of the tension between high culture and low culture, and the perception that only some design work is culturally more valuable. When Raymond Williams declared "culture is ordinary, in every society and every mind" in 1958, he was declaring his opposition to the bifurcation of culture in everyday life into "high culture" and "low culture" [9]. The ordinary work of designing and manufacturing products, illustrating these products for publication, designing and producing a catalogue, and then developing systems of distribution for both catalogue and its contents is a remarkable achievement with a profound and resounding cultural effect. Angela Davis's book, *Art and Work*, describes the prolific commercial illustration industry in Winnipeg in the early 20th century, where at least one studio, Brigden's, employed 65 artists, 25 engravers and five photo-engravers at their busiest seasons.

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These artists were often hired without any previous training whatsoever, and learned to illustrate as apprentices on the job. "The graphic design tradition in Canada, then, could be said to be an oral tradition in two senses: it has been informally transmitted, primarily through studios, schools and periodicals, without having been permanently collected, curated or canonized in print or by institutions, and it is only now being gathered up again as an oral history from the practitioners themselves" [4].

For the Eaton's catalogue, oral histories contribute valuable information at many levels. They can contribute valuable information about how the catalogue was conceived and constructed, they can relay the experience of consumers in interacting with the catalogue itself as well as the goods portrayed in the catalogue, and finally, oral histories can capture the nostalgia that seems to be intrinsic to remembering what it was like to live with the catalogue every day. If we were to compare these assets to American or European design history canons, we run the risk of mistaking orality with a lack of literacy, which devalues the possibilities of enriching Canadian design history. Equally distressing, where design is indeed documented in print—and therefore literate—but represents the ordinary or everyday, it is often mistaken for an inauthentic contribution to our culture.

EVERYDAY STANDARDS AND A CONSTRUCTED VISUAL VOCABULARY

Everyday design, such as the kind found in Eaton's catalogues, constructed a visual vocabulary for its consumers that influenced their daily life. The catalogues provided standards—a constructed measure of how people ought to live—through the display of commodities and a narrative of modern progress. Because these

figure 2. Mason Jar; made in Canada.
figure 3. Sta-Lox Miniature Building Bricks; made in Canada.
figure 4. Uke-A-Tune, toy ukulele; Reliable Plastics CA, 1953.

standards were narrated en masse through the visual vocabulary of each catalogue, designers were ultimately responsible for their role in developing common cultural relationships between Canadians citizens and objects and materials.

Post-World War II saw many new retail products, thanks to injection mould techniques, and new plastic materials. Toys such as the ones made by Peter-Austin Manufacturing company (figure 3) and Reliable Plastics evidently emphasize the manufacturing capability in Canada, but not necessarily the innovation or originality in the design of the toy itself. For instance, there is no design information to inform us about the toy featured in figure 4. It was featured in the 1953 Reliable Plastics catalogue, but it is unclear whether the design of the toy was original or if it copied other popular toys in its time. The catalogue description boasts that this ukulele can be played like a real instrument, but also that it is "moulded in beautiful assorted colours." The emphasis of the material over the design is an artifact of a time where plastic was still an emerging and exciting material. As with the products from Reliable Plastics, Medalta and Hycroft potteries products were equally pervasive and influential in Western Canada. The factories for Medalta and Hycroft were located in the clay district in Medicine Hat, Alberta, which was about 150 acres in size, and was the site of massive productions of clay products, from home goods to clay sewer pipes. Some of the ceramic designers are known in the histories of the various factories in this district, however many of

the crafts people remain anonymous. These crafts people are part of a larger oral history that describes their role in producing some of the most popular and ubiquitous objects for homes in Western Canada. As a part of equating consumption of products as a citizen's duty, the notion of basic standards of living arose around the same time as catalogues began to be distributed in Canada. This is thanks to the proliferation of etiquette books and magazines, but also due to an emerging cash economy in the west combined with new access to retail goods, such as mail order catalogues.

In her book, *Standard of Living*, Marina Moskowitz states that "the standard of living was not a measure of how people lived, according to what they could afford—it was a measure of how people wanted to live according to shared cultural minima" [6]. In keeping with setting or improving living standards, hybrid tent/homes were developed during a time when many families in the west were still living in temporary housing, such as sod houses. Developing a standard of housing by selling a prefabricated home was another huge undertaking by many mail-order catalogues in the early 20th century. From 1910 to 1932, Eaton's supplied sold house plans and all the lumber and supplies needed to build the house. Again, the designers who not only designed and produced the plans for the houses, but orchestrated the delivery system of every supply needed to build these homes, have not been give sufficient acknowledgement for developing a complex DIY system in Western Canada. Eaton's sold at least 40 different house plans, with varying levels of sophistication. These mail order homes remain a legendary aspect of the history of urban development in Western Canada, "many of them serving the fourth or fifth generation of the same family" [2]. The documentation of the homes themselves in addition to the oral histories of the occupants have been largely taken up by local historians, and are most often contextualized within the framework of local histories rather than within the broader concern of Canadian design history.

If the recent history of Canada is so uniquely tied to the production, manufacturing, distribution, promotion, and consumption of material goods, it remains a mystery why design and designers are now not necessary valued in the public sphere as an implicit part of this nation-building or nation-maintaining system. While the contribution of specific designers and their work in their industry, community, and Canadian culture in general, remains important to identify and record, it behooves designers to also point out that the work produced in anonymity throughout the 20th century have made a major contribution to our material and visual landscape. Our manufacturing history, our relationship with plastics and our relationship with natural materials that are regional and imbedded within culture become lost without a historical account.

EMBRACING THE ANONYMOUS

If design was a significant component in "enhanc[ing] democratic life, strengthen[ing] the Canadian nation, and creat[ing] citizen fulfillment" one hundred years ago, there is very little reason why it shouldn't continue to be valued as a component in nation building and cultural contributions now [1]. The roots of Canadian design, no matter how sophisticated or mundane it may be perceived, is located within the acquired material wealth of the average Canadian over the past century. While much of the work discussed in this essay can be criticized as merely nostalgic, mass-produced, unsophisticated, and ordinary, I argue that these works have contributed to a shared visual vocabulary across Canada, and therefore a shared, collective culture worth acknowledging.

The massive undertaking in not only designing and producing these consumer goods, but designing and distributing the catalogues for the goods was unprecedented in Canada, and was one of the most prolific and productive times in our design history. It is by and large undocumented and unarchived. There is little oral history amongst designers in this area, but there still remains a large potential oral history generated by the thousands of Canadians who experienced mail order catalogues and standard-setting products and services first hand. Through these oral histories of consumption, we might better understand our histories of production. Rather than only celebrate the distinctive and iconic design in our Canadian history, I urge our design communities to embrace the plural, the ordinary, the anonymous.

These designed objects mediate daily life. They set standards. They contribute to a complex visual language to the average citizen, and they move through time and space often unacknowledged and more often than not, unattributed. They are a part of our collective heritage and if we begin to acknowledge the current ordinary objects that we depend upon on a day-to-day basis even now, we will see that they remain a part of a collective and authentic everyday experience.

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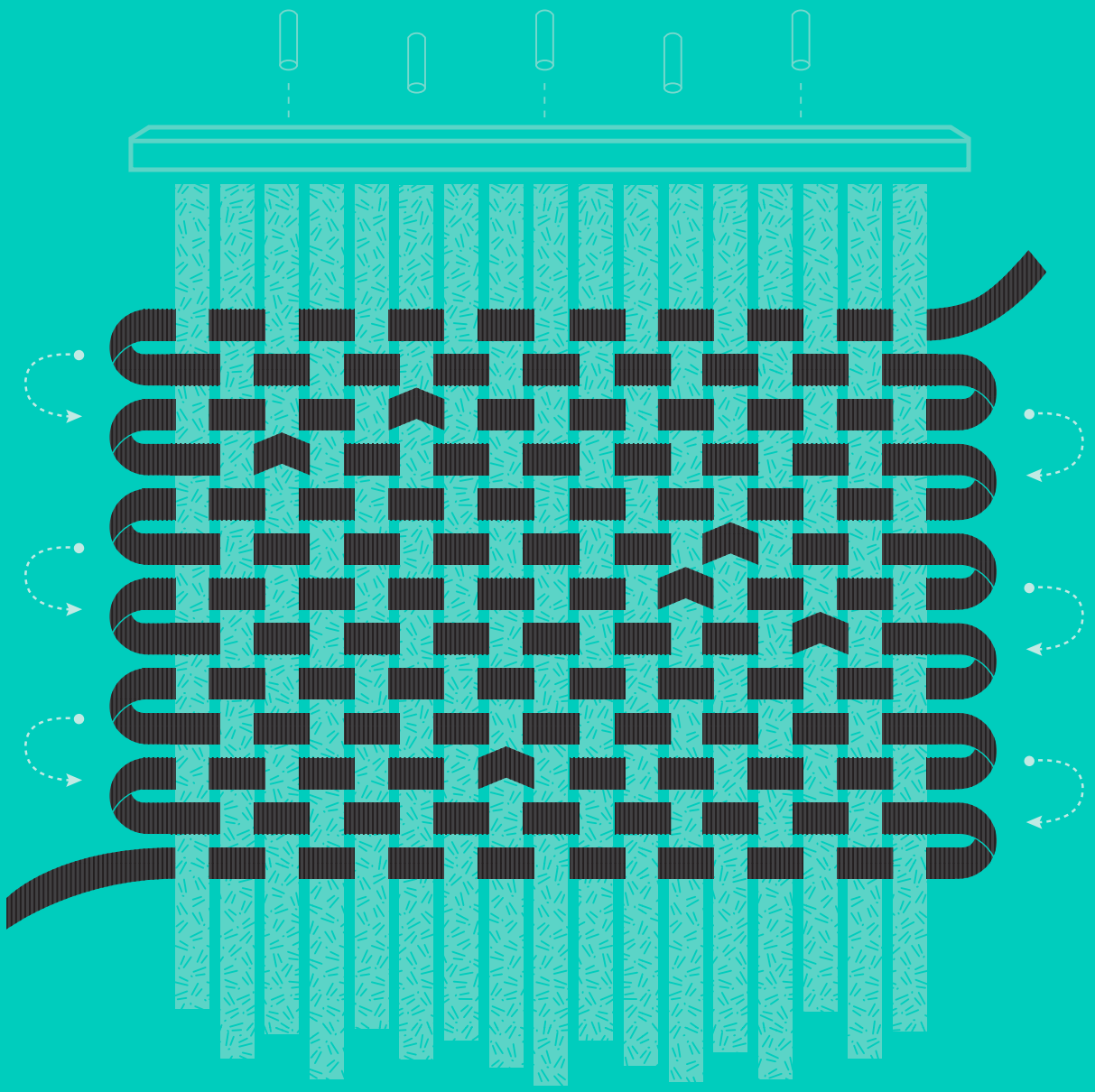


the fabric of design wisdom

Elizabeth B.-N. Sanders

WHAT IS WISDOM? What is design wisdom? This paper will explore the first question using established and emerging definitions. For the second question, I will propose that design wisdom is a fabric that emerges from the intersection of scientific and designerly ways of knowing and doing. Design wisdom can be used both for making sense of the future and for giving shape to the future.

WHAT IS WISDOM?

Before getting into the topic of design wisdom it is helpful to define what the word *wisdom* actually means. The Merriam Webster definition focuses on wisdom as something that you can gain and then hold onto or possess.

> "Wisdom is:
> : knowledge that is gained by having many experiences in life
> : the natural ability to understand things that most other people cannot understand
> : knowledge of what is proper or reasonable: good sense or judgment." [6]

Other definitions focus on wisdom as something that you both possess and use. These definitions of wisdom look toward its application in future life experiences.

> "A basic definition of wisdom is the judicious application of knowledge." [8]
> "Wisdom... is the ability to think and act using knowledge, experience, understanding, common sense, and insight." [8]
> "Wisdom is not simply knowing what to do, but doing it." [7]

Thomas Lombardo, in the most recent issue of the *World Future Review,* expands upon the role of wisdom in our future ways of living.

> "Although wisdom is often associated with 'lessons of life from the past,' wisdom can be given a future focus, defined as the knowledge, desire, and capacity to create maximal well-being in the future, both for oneself and others." [3]

For the purpose of this short paper I will combine these definitions to say that wisdom is about understanding the world as it is today and then doing something with that knowledge in order to "create maximal well-being in the future, both for oneself and others" [3].

ACADEMICS AND PRACTITIONERS

The first definition of wisdom, i.e., wisdom as something that you can gain and then hold onto or possess, describes the academic perspective. We talk about basic research as that which adds to the body of knowledge. The second set of definitions, i.e., wisdom as something that you both possess *and use,* describes the practitioner perspective.

Nassim Nicholas Taleb, author of *Antifragile: Things That Gain from Disorder*, claims that the work that practitioners do is much more important than the work that academics do when it comes to discovery, innovation and technological progress. After having moved from the applied side to the academic side and then back again, Taleb is harsh in his views on academia. A few quotes provide a glimpse of his position and tone of voice.

> "Engineers and tinkerers develop things while history books are written by academics." [5]
> "We don't put theory into practice. We create theories out of practice." [5]
> "Theory came later, in a lame way, to satisfy the intellectual bean counter (in a description of the design development of the jet engine)." [5]

Whereas Taleb's book is certainly a powerful statement of the need to approach discovery from both sides (i.e., academic and practitioner), and is definitely worth reading, it is not clear whether academics will appreciate the message due to his tone. We need an approach that values the collaboration between the perspectives of academics and practitioners in the creation of wisdom that is more broadly defined.

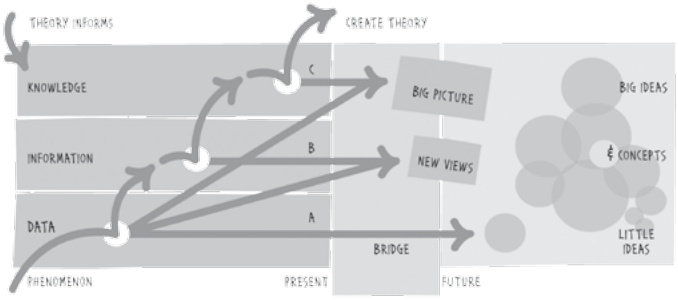
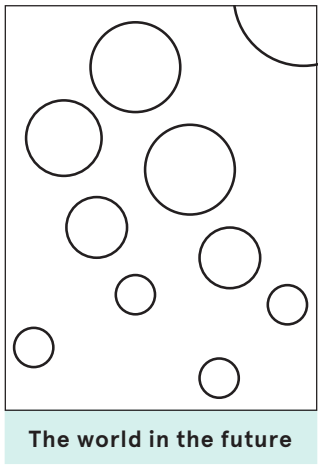


figure 1. Analysis of messy data for the front end of design from Sanders and Stappers, 2012.

WHAT IS DESIGN WISDOM?

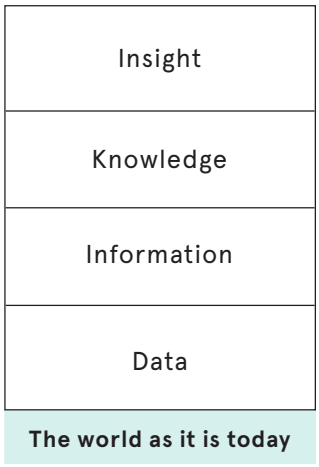
In order to talk about design wisdom, I'll start with a framework that is useful for the analysis of the messy data characteristic of the fuzzy front end of the design and development process. Figure 1 shows the version of the initial framework that Pieter Jan Stappers and I introduced in our book *Convivial Toolbox* [4].

We need an approach that values the collaboration between the perspectives of academics and practitioners in the creation of wisdom.



The world in the future

figure 2. The generative side where ideas take shape.



The world as it is today

figure 3. The analytical side where sense is made.

The framework for the analysis of messy data shows that the path of analysis starts in the lower left with the collection of data related to the topic or the phenomenon under investigation. The layers of analysis are based on Ackoff's DIKW scheme (where the letters D, I, K and W stand for Data, Information, Knowledge and Wisdom), which distinguish different levels of sense making [1]. In the framework data are documented, organized and reorganized into information. Information is then transformed into knowledge as the analysis proceeds. Ideally, knowledge is further transformed into insight or wisdom. Theory is said to set the boundaries for this investigation and to inform the analysis process. Sometimes new theory is created as a result. Analysis moves upward and to the right, from the analytical side to the design side of the framework with crossovers between research and design taking place at every level of sense making. Bigger ideas emerge at higher levels of sense making.

Now I'm going to use the framework as a model of design wisdom and will start by deconstructing the framework into its core components.

Figure 2 shows the generative/creative side of the front end of the design space where new ideas and concepts emerge. It is here that designers explore the future. For years designers worked primarily in this space ideating, sketching and iterating on ideating and sketching. The goal of working in this space is to imagine the world as it could be and to give shape to the future.

Figure 3 shows the analytical side of the front end of design space where we use methods and tools to understand the world as it is today. This side of the design space is often referred to as research. Here is how it works. We usually start with a theory that informs the research plan. We collect data about the phenomenon being explored according to the plan. We then organize and make sense of the data by working our way up the levels until we get to the level of wisdom whereby we can feed back into the theory with confirmatory or contradictory evidence. Scientists use this model of the research process in order to discover and make sense of the world as it is today.

Use of the scientifically-based research process as a newer addition to design practice has grown dramatically since the 1960's. Proponents of the design research process have tended to come from the social sciences and use research methods and tools to understand the current context in order to inform the design process. Designers have had mixed reactions to such design research since they are often more interested in what could *inspire* their creative process than in what could *inform* their creative process.

However as the challenges facing humanity have become more complex and urgent, designers are now finding that they need to be informed (and perhaps inspired) by the analytical side while they are generating and exploring ideas in the design space. When we are working with wicked problems and/or large systems that are dynamically changing, we need to combine the analytical and the generative sides of the design space.

USING THE FRAMEWORK FOR DESIGN WISDOM

In the framework for design wisdom that is shown in figure 4 there is now a large space between the analytical and the generative sides. Optimists refer to the space as a bridge and pessimists refer to the space as a gap. But everyone agrees that we need to play on both sides of the bridge or gap to address the challenges that design is being asked to consider today.

So how do we play on both sides? Should we start on the analytical side and use the knowledge and wisdom gained there to inform the generation of ideas on the creative side? That is the approach that design research has been using to date. We start with the research phase and then move on to design. The arrows in figure 1 point this way.

But there are other ways to work the framework. We could, for example, start with generating ideas on the design side and then use the ideas as input toward a more analytical exploration. This is what is happening today in the design-led approaches such as

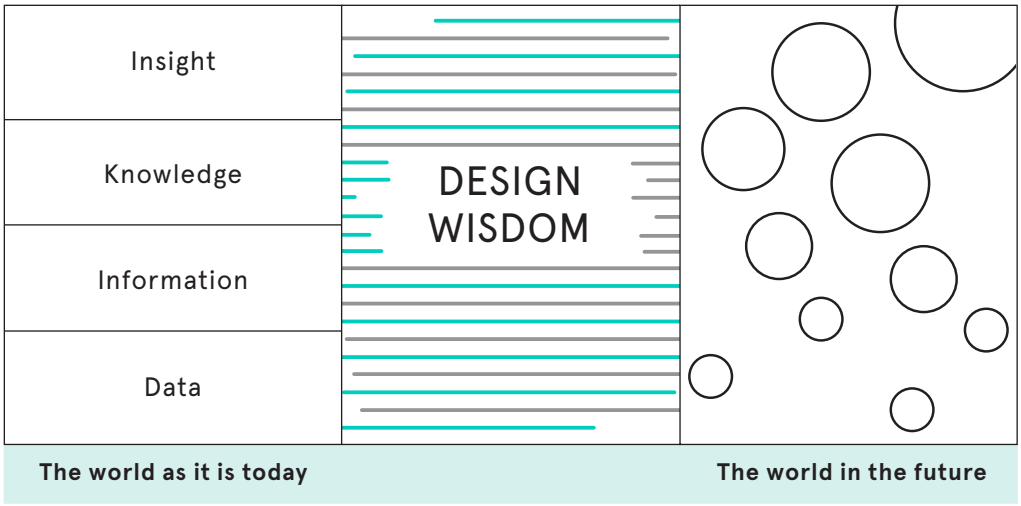


figure 4. The framework for design wisdom as the bridge between the analytical and generative sides.

design fiction (e.g., Dunne and Raby [2]). Here, designers make things (e.g., objects, prototypes, events, etc.) in order to make people think. To make them think about, for example, the prevailing and failing approaches to the tactical application of new technology.

Or we could work both sides simultaneously. Let's look more closely at the large space between the left and the right sides. Think of that space as a fabric that weaves the results of analytical activities together with the results of generative activities. If we can work both sides simultaneously we can see the emergence of a new fabric. We can see that the generative side stirs and provokes the body of knowledge that grows on the left. From the generative side we can see doodles, sketches, probes, provocations, prototypes and provotypes that weave into the fabric. And we can see that the analytical side raises questions and challenges that perturb the generative activities taking place on the right. From the analytical side we can see patterns, principles, themes and insights that weave into the fabric.

So how will we work together to weave the new fabric of design wisdom? There are certain to be different types of people on the two sides who are out of their comfort zone when trying to adapt to each other's ways of working. I propose that the iterative cycle of making, telling and enacting can be used to facilitate the weaving [4]. This is a design language that everyone understands and can use. It is simultaneously visual, verbal and enacted. The iterative cycle of making, telling and enacting can be put into action by:

- Making, telling and enacting new kinds of stories,
- Using people's stories about their futures to evoke their making of new stuff,
- Telling about and sharing ideas about future stuff, and
- Putting the stuff that people make back inside their future stories, etc.

BENEFITS OF EXPLORING THE NEW FABRIC

On the bridge between research and design in the future we will see the transdisciplinary collaboration of people with very different world views. We will see people who seek to understand the world as it is today, others who strive to make sense of the future as well as people who are driven to give shape to the future.

The framework for design wisdom reveals that the role of designers and design researchers is continuing to grow in scope and relevance for our collective futures. They are becoming the facilitators of participation, provocateurs and activists. They will continue to be the makers of stuff for the future.

In the near future practitioners, including designers, will be seen on equal but different standing with the academics. Both perspectives will need to be intertwined in weaving the new fabric on the bridge between academics and practice. The bridge/gap will serve as a place for the remixing of ideas from both sides. The bridge is the fabric upon which we make sense of and give shape to the future. The fabric of design wisdom.

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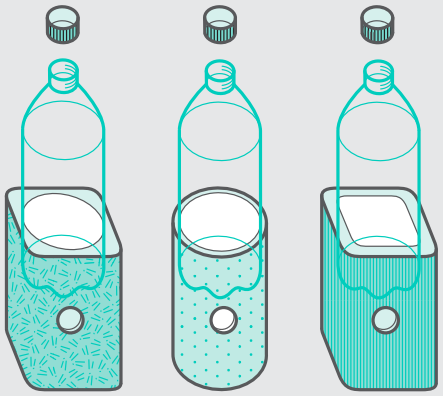
Scott Yu-Jan



JOBO

System Driven Products through Upcycling

CONSUMER CULTURE HAS disconnected us from the things we own. We are immersed in a cycle of buying commodities and producing waste. Replacing and/or buying new things instead of fixing, reusing, and making has become the obvious solution. In this project, my partner Sie Gal and I aimed to bring back these ideas by confronting individuals with the waste they produce and to motivate them to rethink their role in a sustainable future. Through a co-creation process with five-year-old Devon and his family, we created an interactive object named Jobo. Jobo is an assembly game that allows users to practice upcycling in which plastic bottles can be connected to form structures. It gives used products a second lifespan and introduces children as well as adults to Do-It-Yourself (DIY) culture. The project aims to present the concept of upcycling in a fun and engaging way to people of all ages, allowing them to rethink the role of waste in their everyday lives. In this paper, we examine the process of creating and implementing a behaviour-changing design through co-creation. The paper also reflects on the effectiveness of existing methods for teaching sustainability and proposes the implementation of an educational system driven by products.

BACKGROUND

After proposing a series of broad concepts and directions to Devon's parents and a design studio class led by Christian Blyt at Emily Carr, we found that the most popular concept was one where we would incorporate an upcycling aspect into our interactive object because of the educational quality. Sie and I started our research into existing activities and designs aimed at the same goal. We researched innovative activities in the DIY community as well as recently popularized designs that incorporate upcycling. Additionally, having experienced some DIY activities in our youth that promoted upcycling, we were curious to understand what made some of these activities and designs more successful than others.

Designs that have efficiently implemented elements of upcycling are often popular online and frequently featured on design blogs, such as old magazines stacked to form stools and recycled plastic bottles assembled to form chairs and planters. There was a wide variety in terms of materials used and approaches taken; we focused on the connection these concepts and designs created with their users. Although these objects were featured on blogs and may have become popular online due to their innovation, there was undoubtedly an aspect missing that kept them from becoming mainstream. In an article by Sheryl Nadler, who writes about the process of creating DIY wearables, she discusses the satisfaction that is gained from expressing individuality by wearing something created through personal creativity and effort [2]. This aspect is what is missing from upcycled furniture seen online—these objects are either completely dependent on the user's existing skills or they are limiting and allow no room for the user to exercise their creativity.

Another issue is that most of the results from upcycling-themed projects have a rustic appearance to them. This may be another reason why existing designs have failed to flourish. When done poorly, upcycled objects are often seen as junk, which is less socially acceptable when the object is used as a children's toy [4].

CO-CREATION

On the first day of our meeting, we began with some drawing activities to understand Devon's interests. An open-ended activity helps people make things that express their thoughts and feelings [3]. We learned about his interests in drawing, sports, and playing videogames. After discussions with his parents, we also learned about their values and hopes for a children's toy. We went through Devon's toys with him as well as with his parents, discussing what they felt was successful and what was not. From Devon's parents' perspective, they hoped for a toy that is not only educational but that also allows for family involvement. After a meeting to discuss their expectations, limits, and desires regarding toys, we began to gain greater insight into their lifestyle. We determined the life cycle for the average children's toy in their household and, more importantly,

what happens to old toys. We learned that whenever a new toy or game is bought for Devon, he has to choose one of his existing toys to be discarded. This can mean either donating it to a local thrift shop, to other family or friends, or simply throwing it out to avoid clutter. The toys that have survived this elimination process and the factors that helped Devon make these choices intrigued us the most.

Although it was difficult for Devon to express the factors that help him determine which toys to keep, we identified that while his remote control cars, as well as some modular assembly games, have lasted the longest, an important reason for keeping some of his toys was that the whole family could enjoy them together. When we proposed our concept of creating an activity that embraces upcycling to Devon's parents, we were surprised to learn that they had not heard of this approach to sustainable design. After explaining the concept to them, they were very enthusiastic about introducing it to Devon and having a new activity for the whole family to enjoy.

FINDINGS

When sustainable designs that incorporate upcycling require crafting skills and special tools from their users, they begin to fail as products and act more as systems that encourage their users to learn the tools and the craftsmanship, often in the form of a kit or community. While these products still achieve their goal of educating users in sustainable design, the specialization of tools and skills drastically diminishes the size of the user group, as they lose appeal to the general public.

On the other hand, when a design is too simple and neglects user-involvement, it also fails as a successful product. These features shorten the product's lifespan and grant it early entrance into the landfills. Throughout this research process, the key lesson we learned was that the most successful product designs typically are ones that drive a system. And, vice versa, the most successful system designs are ones typically driven by a product. In these cases, products do not necessarily have to be tangible physical objects but can also be apps, websites, posters, or advertisements. The design of both the product and the system become equally important in reinforcing their goals and intentions.

METHODOLOGY

It was critical that we create an interactive object for Devon to learn about upcycling through play. It was also important that we determine the ideal educational system for this product, specific to Devon, his family, and those in other contexts such as elementary schools or educational toy markets.

In Chris Haas and Greg Ashman's article, "Kindergarten Children's Introduction to Sustainability through Transformative, Experiential Nature Play," they demonstrate the process of educating kindergarteners about sustainability by having them frequently spend time in natural outdoor settings [1]. Using this logic, it made sense that if the goal of Project Jobo was to make users rethink their waste impact on their environment, the design should somehow force users to interact with their "waste."

Moreover, it was important that our design allow for user involvement in order to form a connection with the object in the DIY sense that Nadler describes. The process had to be relatively effortless so that even a five-year-old, such as Devon, could achieve the intended purpose. Sie and I decided that our design also had to create a new perspective and system in which the reused material would no longer be seen as waste, but as a resource instead. We wanted to normalize the confrontation between individuals and the waste they produce so excessively. We had to make the process of upcycling fun, engaging, and desirable.

figure 1. Jobo connects plastic bottles to form custom structures.

figure 2. Jobo in action; showing the freedom of assembly to create custom forms.

DESIGN PROCESS

Upon deciding to focus our upcycling object on polyethylene terephthalate (PET) plastic bottles due to the abundance and variety of this type of waste, we began our prototyping process. We developed a concept of car tracks that Devon could then connect the bottles to in order to create obstacles for his remote-controlled cars. Although he enjoyed this concept, he was not old enough yet to have the cognitive skills required to control his remote control car through the obstacles steadily. Instead, we went with a design Devon liked, which is based on a simple modular connector for the bottles. When he first connected two bottles together, he thought of his creation as a hammerhead shark. When a third bottle was connected, he thought of a gun. He enjoyed making these physical connections and mental associations; creating these abstract forms stimulated his creativity.

Through two additional meetings with Devon and his parents, we were able to further prototype the design, and have it proposed, approved, and then finalized. Worrying that our design would be too hard for someone so young to figure out right away, we were surprised by how quickly Devon understood the function of the connectors with little to no guidance. We manufactured each connector using a complex lamination process of seven layers of wood veneer. Each connector tube, as a result, is extremely durable and lightweight, with the manufacturing process producing barely any material waste.

CONCLUSION

Having a physical product to drive the educational system of upcycling had a lot of impact in the end, even though the manufacturing of the connectors took effort. Having a physical product that doesn't function by itself, and only works in the presence of plastic bottles will motivate Devon and other users to rethink the role of waste in their everyday life. The Jobo connectors act as constant reminder to individuals to ponder their role in producing waste in our community.

At a young age, Devon understands the concept of upcycling, and that not everything instantaneously becomes garbage the moment it finishes serving its intended function. Through rebranding the identity of waste into an entertaining children's toy, Devon is more aware and understanding of his impact on the environment.

ACKNOWLEDGEMENTS

I would like to thank my Project Jobo partner, Sie Gal and the course instructor, Christian Blyt. In addition, I would like to thank Eugenia Bertulis, Nico Jan, Grace Leung, and of course our amazing co-creators, Devon and his family.

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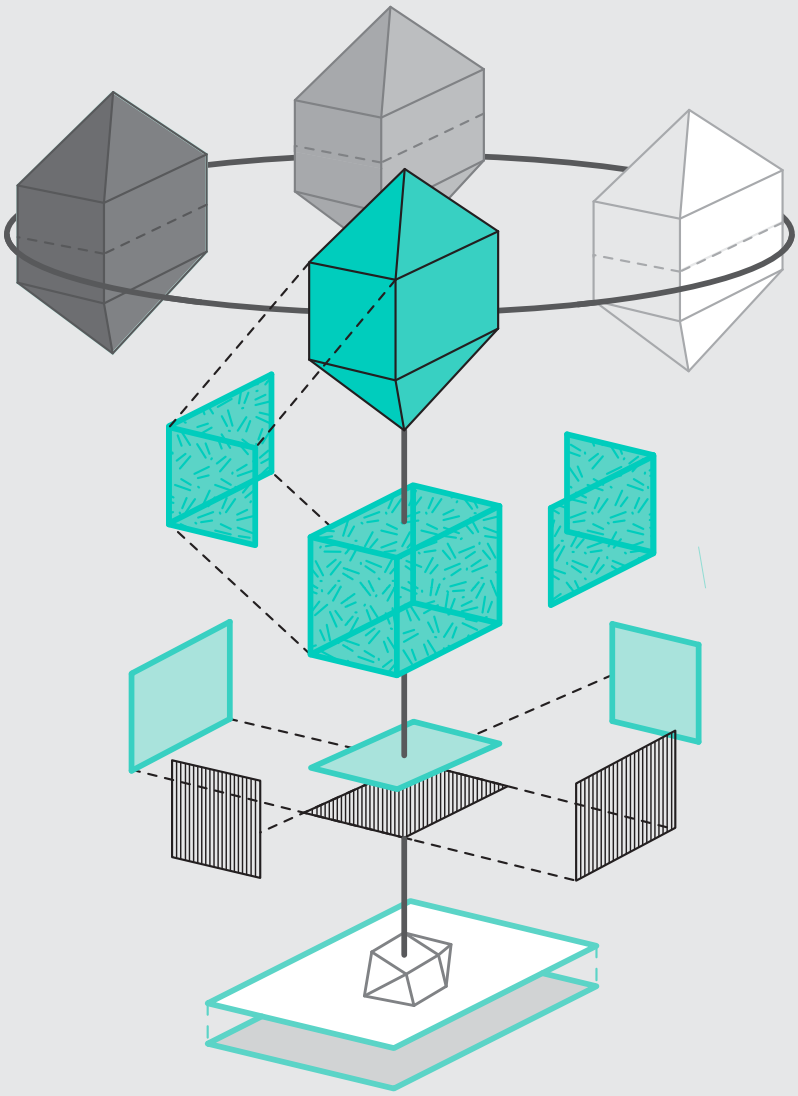


prototyping risks when design is disappearing

Cameron Tonkinwise

THE FOLLOWING TAKES inspiration from Liz Sanders and Pieter Jan Stappers' recent metahistorical editorial article which periodizes design as:

> 1980s – expert discipline-specific design of products on the basis of market research
>
> 2010s – interdisciplinary designing of interactive experiences on the basis of participatory research through practice
>
> 2040s – generalized co-design of sustainable systems [21]

In this kind of visioning, a key shift is the movement of prototyping from a late stage testing device in the 1980s, through being a more front-end innovation tool currently, to designs, now understood as systems rather than things, being a kind of perpetual prototype. I would like to trouble this aspiration by taking into consideration some current design process trends. The intention is to ask about appropriate kinds of prototyping giving present and future risks.

IMAGINING AND REALIZING

Designing is the process of making futures (see the important Open University textbook *Man-Made Futures*, [8]). There are at least two distinct aspects to this process. Each aims at a different sense of "the possible" or what it means "to create." One is disruptively innovative; it seeks to break with how things currently are, open up the new. The other is more instrumentally pragmatic; it seeks to work out how current things might be transformed, what it is practicable to make.

Ideally, designers are equal parts fantasists and realists. They can imagine the most far-fetched unreal things; but then they can also focus on questions of practicability, how to make those imagined things real. Designing should be a dialectic between to these two different kinds of possibility.

Designers have tools and skills to manage this dialectic, techniques that give the expertise of designing its distinctiveness. All of these are ways of making futural possibilities partially real in the present so that they can be evaluated and detailed—chief among these are: prototypes.

VISUAL PROTOTYPING

The term "design" refers etymologically to the process of drawing. Sketching services both sides of the designing dialectic. Visual perception's rush to associate marks on pages or screens with represented things means that drawing is a creative process, generating new possibilities even to the mark maker [14]. Hence "visual thinking," where the emergent image seems to back-talk to designer abductively. On the other side, visual representations of possible designs become stages for a series of thought-experiments about the material feasibility of design. Designers, skilled at reading visualized designs (like plans, elevations, exploded views, mechanism or joinery details, etc), can make assessments about buildability, operability, etc, of an imagined design.

Design-through-visualization was certainly a major breakthrough in how humans made futures. The seminal publications of John Chris Jones and Christopher Alexander suggested that the whole scale and pace of modernization depended on the "creative leaps" and "virtual prototyping" that self-conscious designing-as-drawing afforded [15, 1]. Jones and Alexander were writing amidst the Design Methods Movement. This was the moment when design researchers felt that the situations in and for which designers were making futures were becoming much more complex. The argument is related to the metahistorical one Vilem Flusser was fond of: when things got too complex to speech, we started writing; when things got too complex for writing, we started designing-by-drawing [11]. Now that things are too complex for diagrams and sketches, we—what?

The Design Methods Movement perhaps failed—it was at least renounced by both Jones and Alexander—because, at its worst, it conflated two different kinds of feasibility: technical and social. The computation that was arriving at the time could process complex issues related to manufacturability and functionality; but it was wrong-headed to imagine that cultural/political complexities could be resolved in the same way. This is why design researchers in North America began to explore more dialogical ways of negotiating "wicked problems" such as hermeneutic dialogue mapping and the double-loop learning of reflective practice, at the same that more participatory approaches to human-computer interaction were being developed in Scandinavia [2, 6, 10, 23].

ENACTING WITH PROTOTYPES

What remained designerly about these social practices was their materiality. Attaining consensus on a problem-frame is one thing, but coming to an agreement about a promising solution-field is another. To do this, designers shifted from 2D to 3D, or in truth to 4D: prototypes, enacted in scenarios. A physical prototype accesses embodied aspects of interactions that can be missed when merely imagining from visual representations. Whilst a prototype appears to foreground the thing itself, its materialization in fact allows consideration of the design will feel, how it is to interact with. The object of prototyping is thing-being-used-by-someone.

In the recent history of professional design, especially in the realm of digital products, there has been a slide, on the practicability of side of the designing dialectic, from User-centered Design to Human-centered Design, that is to say, from issues of Usability to Experience. This is because what enacted prototyping reveals is not just things about the product (whether it can be made to enable this or that interaction), but also things about people (whether they can be enabled to make this or that interaction). Improvising with physical prototypes (of varying levels of fidelity, with respect to both the prototype and the scenario) accesses aspects of complex futural social feasibility that the Design Methods Movement failed to discern and that wicked problem negotiation could only talk about.

Transition Design is an attempt to preserve the power of prototyping as an anticipatory tool.

What, though, of the other side of designing possibilities? What remains consistent over the design history that I have so far schematized is that the designer is the innovator, the expert member of the creative class. What changes appears to be only how to determine what possibilities can be made socio-technically real. But surely designing, as being-in-service, should "get" its innovations from or at least with those people it is servicing? [19]

Liz Sanders' work is exemplary in its attempt to find how to work with people in order to access the new rather than only the realizable [20]. Sanders' is motivated by the epistemological problem of how to get non-designers to access new possibilities rather than present actualities. If you ask non-designers what they want, they can mostly only respond with what they already know; how to open people up to "what else could you want," to what is latent. Sanders' insight is that prototyping can be generative of possibilities not just evaluative. Just as sketching accesses perceptual abductions, so does interacting with physical forms. Designing kits of materials and components, and situations in which people are motivated to interact in a range of ways with those kits, allows designers to co-create with those they aim to service. In this, Sanders' generative design research strategies are similar to cultural probes and a range of other "engaging" design processes [4].

I want to ask how generative though? Do these prototypical techniques generate possibilities that are disruptive of business-as-usual? What are the generative design research techniques that get people to imagine the (currently-)impossible-yet-necessary? Can generative design research access radical alternatives?

GENERATING SUSTAINABLE POSSIBILITIES

An interesting test for generative design research's way of handling the dialectic of designing is sustainability. I am assuming here that our societies are severely unsustainable, both because of the direct ecological impacts resulting from the materials intensity of the global consumer class, and because of the inequality that is endemic to the corporate economies that service that consumerism.

Our current unsustainability, especially when understood in terms of materials intensity, is in large part a result of design—whether imposed by modernist design experts or tempered by user- or even human-centered design research. Generative design is not especially culpable—at its best it tries to access what might finally be truly needed by its participants rather than just-another creative-yet-still-feasible idea. However, generative design research's materials-based techniques do tend to encourage creative innovation mostly with respect to more thing-based solutions to latent concerns (rather than leading to service systems for instance, or structural dissolving of those concerns, such as no-build options, value- or lifestyle shifts, etc).

A second thing to note is that our unsustainability is a massive problem, of a size that demands truly radical responses. It is as if there is a kind of problem beyond wicked: in addition to being complex (a large number of interdependent variables) and wicked (because some of those variables are people, who act in not always fully rational ways and change their minds), sustainability is also just a big problem—solutions will require nation-sized infrastructure rebuilding (fuel switching, city renovation and even relocation) and similarly nation-sized notion re-conceptualizations (new ideas about freedom and autonomy, cost and responsibility, etc). Can we get this level of "Big and New" from processes like generative design research?

NEOMODERNIST VISIONS

This is perhaps why right now there is a resurgence of modernist utopianism. Technologists, emboldened by excessive wealth, are reasserting the "dream big" side of the design dialectic. Sometimes the argument is directly related to sustainability: large-scale technological moonshots are now needed to protect the natural resources upon which our ways of living depend—nuclear power, transgenic crops and geoengineering, to quote the subtitle of Stewart Brand's *Whole Earth Discipline* [5]. Designers today are extolling fantasies of transhumanist hyperloops in digitized echoes of their founding fathers—the streamline designers like Loewy and Bel Geddes. If a commitment to social-research-based design risked miring the dialectic of making possible futures in the currently pragmatic, these (inter)stellar technoliberationists seem to float at the other end of the dialectic in the unrealizable.

Neo-modernist visions draw attention to whole other axis to designing. To explain, consider the "proactionary" discourse that sometimes accompanies these radical technological ambitions. The Proactionary Principle was drafted in reaction to the Precautionary Principle, a central component of "sustainable development" [18, 22]. Ecological politics is defined by its focus on risks [3]. It inserts into political values a concern for catastrophes that might happen, such as whole ecosystems collapsing or climatic systems shifting irreversibly in the near future. The subjunctive quality of a risk defies conventional positivist epistemologies. As a result the Precautionary Principle institutes the need for technoscience to advance only with caution, not undertaking a project until its risks have been certifiably minimized. Advocates of the Proactionary Principle argue that, when it comes to problems as big as sustainability, risks of inaction outweigh risks associated with action, so precaution should be set aside for projects that might conversely afford significant gains in (technical) sustainability.

FORSEEING CONSEQUENCES

Talk of the Proactionary Principle remains relatively marginal—though I will come back to a more common manifestation with design practice—but for now it is important to note how this foregrounds a whole other aspect of design as future-making. Design's task is not only to imagine what *could* possibly be made real, but

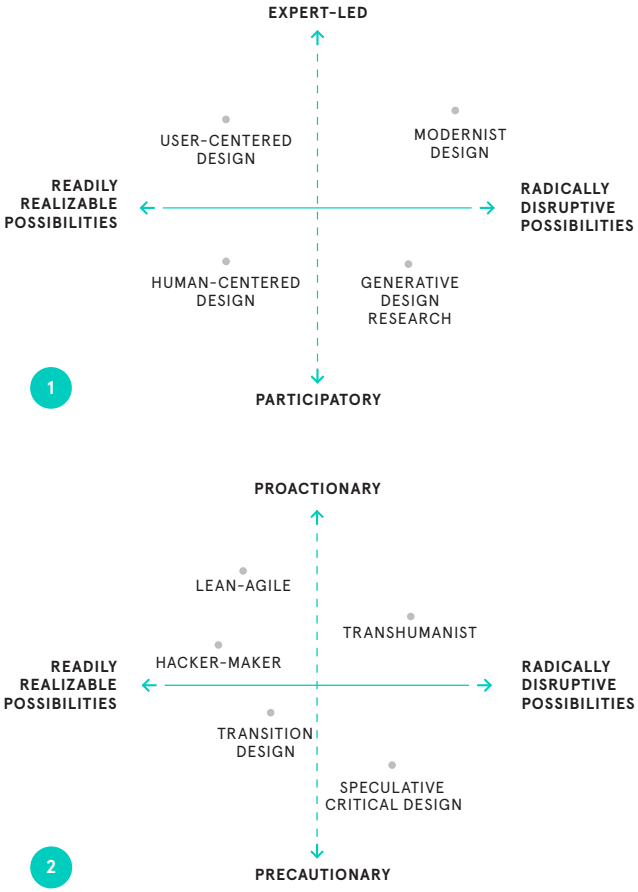
also to determine what *should* be made real, what would be *preferable*. This is not just a matter of ascertaining what is useful, but of foreseeing the consequences of a design becoming widely used. Visualizing and prototyping that designers do when designing can allow them to anticipate what their designs will design, discerning the risks that follow from any design's realization. To design a car means to envision not just an innovative form of mobility that is also manufacturable and usable, but also to discern the ecological risks associated with habitual driving—traffic, sprawl, climate change. To redesign an algorithm-derived component of Facebook requires not just testing its buildability, but also foreseeing how this may expose some people with their knowledge (see Mike Monteiro's talk, [17]). These are the kinds of risks that proactionary advocates want to exempt designing from.

Can generative or human-centered design processes responsibly anticipate the wider consequences of designs? Throughout modernity, it was experts who were called upon to advise on the ecological and social impacts of technological developments. But recent arguments have suggested that risks need to be negotiated in more participatory ways. Functowicz and Ravetz call "post-normal science" the deliberations demanded by high risk, high uncertainty technological developments [12].

There are two connections to design. On the one hand, design, as a source of "radical innovation," is these days involved in larger-scale disruptions that fall into the postnormal category. On the other hand, to enable evaluation of technoscientific initiatives, deliberators need to be furnished with designs (sketches, prototypes) of the ways in which those initiatives might manifest in the world. The latter can be seen as part of the role that Speculative Critical Design might play [9]. In this form of Design Research through Practice, high fidelity prototypes contextualized in rich scenarios are created to evaluate not a proposition's realizability, but rather its societal desirability [16]. However, as with the discourse of the Proactionary Principle, Speculative Critical Design is a comparatively marginal practice, located mostly in University contexts.

VISIONLESS ITERATING

What is dominant in commercial design at the moment are methods that do nevertheless have proactionary elements, by which I mean a deliberate ignoring of imagining future consequential risks. I am referring here to, for example, Agile and Lean product development. These are distinct forms of design management and each a broad church, but consistent across them is a commitment to accelerated iteration of products released to live markets. Design is driven by real-time feedback on how "Minimum Viable Products" (MVP) are being used. The rationale is that many high consequence risks, and opportunities, are unanticipatable. Rather than imagine or sense what these "blackswans" might be, designers should instead focus on being able to respond



figures 1 & 2. Dialectic of Design as Making Futures.

immediately to what emerges. These Lean Agile philosophies eschew the grand visioning aspects of proactionary advocates, but are sympathetic with the downplaying of risk anticipation. As Joi Ito, head of MediaLab at MIT is fond of saying (though I am not sure of his evidence for this claim), "*the* cost *of* assessing risk *is now often greater than the* cost of failing" [7].

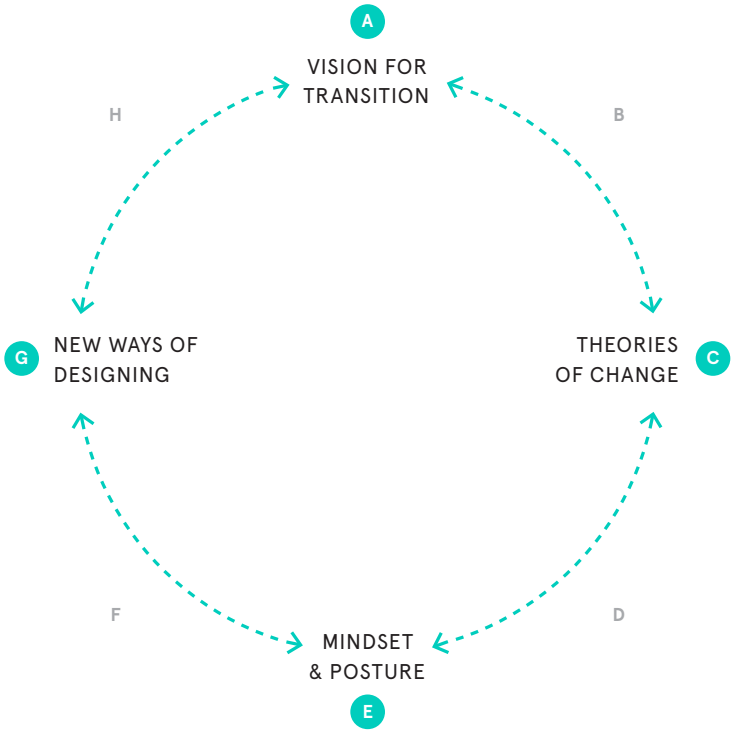
If Lean Agile, etc, aim at accessing the realizably innovative, the other end of the design dialectic might be Maker culture. These neo-tinkerers also pursue multiple iterations in order to discover serendipitously new uses for existing combinations of technologies, software and/or materials. There is a similar anti-visioning driving these hackathons, and in all the rapid building there is also no anticipation of consequential risk.

In either case, the approaches deploy what could be called a "generalized prototyping." Lean Agile beta-releases and hacked systems are more than prototypes; they are live products being used by people who are not explicitly structured as research

subjects. The MVPs are evaluated in terms of the current ways in which they are being used; they are not being evaluated as (prospective) designs. Certainly these platforms are not finished products; there is a clear sense that they remain in-process; ever-frequent updates and even complete pivots will be made. In this sense, prototyping is no longer a stage within design, but the only outcome of design. Without forethought, prior evaluation, whether against a strong vision, or of consequential risk, is this still design? Is designing as foreseeing disappearing beneath permanent iteration?

PROTOYPING FOR STAGES OF TRANSITION

These questions are some of the context for the School of Design at CMU's attempts to talk about *Transition Design*. The term acknowledges the need for multi-level, multi-stage change, but it tries to preserve visioning as part of the process, both of desirable-even-if-not-yet-feasible futures, and of consequential-risks [13]. To put it another way, Transition Design is an attempt to preserve the power of prototyping as an anticipatory tool. This requires committing to some kind of finished product (or platform) for significant amounts of time. Transition Design aims to promote staged change, not forever changing.



TRANSITION DESIGN FRAMEWORK
Co-Evolving Areas of Knowledge, Action and Self-Reflection
(Irwin, Tonkinwise & Kossoff).

A. A VISION FOR THE TRANSITION to a more sustainable society is needed. This calls for the reconception of entire lifestyles in which communities are in symbiotic relationship with the environment. Lifestyles are place-based yet global in their exchange of technology, information and culture.

B. The vision of the transition to a sustainable society will require new knowledge about natural, social, and "designed" systems. This new knowledge will, in turn, evolve the vision.

C. Ideas, theories and methodologies from many varied fields and disciplines inform a deep understanding of the DYNAMICS OF CHANGE in the natural and social worlds.

D. New theories of change will reshape designers' temperaments, mindsets and postures. And, these "new ways of being" in the world will motivate the search for new, more relevant knowledge.

E. Living in and through traditional times requires a MINDSET AND POSTURE OF OPENNESS, mindfulness, a willing-ness to collaborate, and "optimistic grumpiness."

F. Changes in mindset, posture and temperament will give rise to new ways of designing. As new design approaches evolve, designers' temperaments and postures will continue to change.

G. The transition to a sustainable society will require new ways of designing that are informed by a vision, a deep understanding of the dynamics of change and a new mindset and posture.

H. New ways of designing will help realize the vision but will also change/evolve it. As the vision evolves, new ways of designing will continue to be developed.

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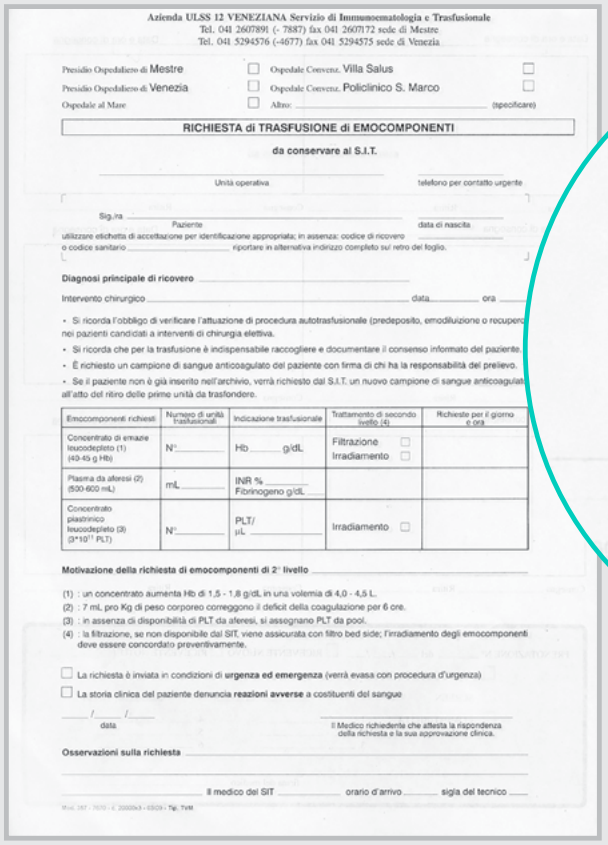
why evidence-based design?

Jorge Frascara

DESIGN HAS MOVED on fuzzy grounds for a long time. Decisions have followed best practices, opinion leaders, "good taste," aesthetic fads, and personal assumptions about what works and what doesn't. Since the times of William Morris, through the Bauhaus times, well into the XX Century, and even today, many designers worked all their lives on those grounds because research and evaluation were not part of design culture. They have existed in the culture of colour since the 1700s, and in the legibility of print since the first studies by Tinker in 1925. It took hold in advertising in the 1950s: if the product you were announcing in your smart looking campaign did not sell, your agency lost the account. But if you were designing a leaflet for a pharmaceutical product, as long as all the information that the law required was there, you were good.



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Ospedale al Mare ☐ Altro: _____ (specificare)

RICHIESTA di TRASFUSIONE di EMOCOMPONENTI

da conservare al S.I.T.

Unità operativa _____ telefono per contatto urgente _____

Sig./ra _____ data di nascita _____
Paziente
utilizzare etichetta di accettazione per identificazione appropriata; in assenza: codice di ricovero
o codice sanitario _____ riportare in alternativa indirizzo completo sul retro del foglio.

Diagnosi principale di ricovero _____

Intervento chirurgico _____ data _____ ora _____

- Si ricorda l'obbligo di verificare l'attuazione di procedura autotrasfusionale (predeposito, emodiluizione o recupero) nei pazienti candidati a interventi di chirurgia elettiva.
- Si ricorda che per la trasfusione è indispensabile raccogliere e documentare il consenso informato del paziente.
- È richiesto un campione di sangue anticoagulato del paziente con firma di chi ha la responsabilità del prelievo.
- Se il paziente non è già inserito nell'archivio, verrà richiesto dal S.I.T. un nuovo campione di sangue anticoagulato all'atto del ritiro delle prime unità da trasfondere.

Emocomponenti richiesti	Numero di unità trasfusionali	Indicazione trasfusionale	Trattamento di secondo livello (4)	Richieste per il giorno e ora
Concentrato di emazie leucodepleto (1) (40-45 g Hb)	N°_____	Hb _____ g/dL	Filtrazione ☐ Irradiamento ☐	
Plasma da aferesi (2) (500-600 mL)	mL_____	INR % _____ Fibrinogeno g/dL _____		
Concentrato piastrinico leucodepleto (3) ($3*10^{11}$ PLT)	N°_____	PLT/ µL _____	Irradiamento ☐	

Motivazione della richiesta di emocomponenti di 2° livello _____

(1) : un concentrato aumenta Hb di 1,5 - 1,8 g/dL in una volemia di 4,0 - 4,5 L.
(2) : 7 mL pro Kg di peso corporeo correggono il deficit della coagulazione per 6 ore.
(3) : in assenza di disponibilità di PLT da aferesi, si assegnano PLT da pool.
(4) : la filtrazione, se non disponibile dal SIT, viene assicurata con filtro bed side; l'irradiamento degli emocomponenti deve essere concordato preventivamente.

☐ La richiesta è inviata in condizioni di **urgenza ed emergenza** (verrà evasa con procedura d'urgenza)
☐ La storia clinica del paziente denuncia **reazioni avverse** a costituenti del sangue

_____/_____/_____ data _____ Il Medico richiedente che attesta la rispondenza della richiesta e la sua approvazione clinica.

Osservazioni sulla richiesta _____

_____ Il medico del SIT _____ orario d'arrivo _____ sigla del tecnico _____

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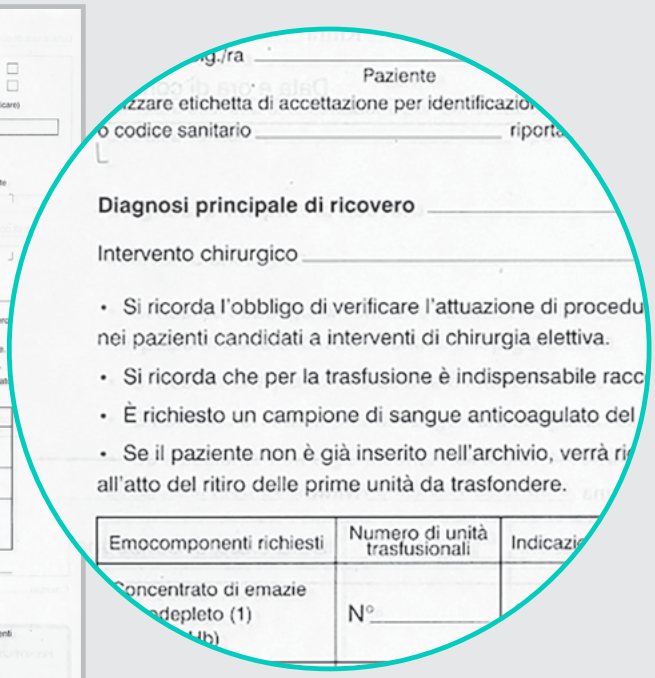
1



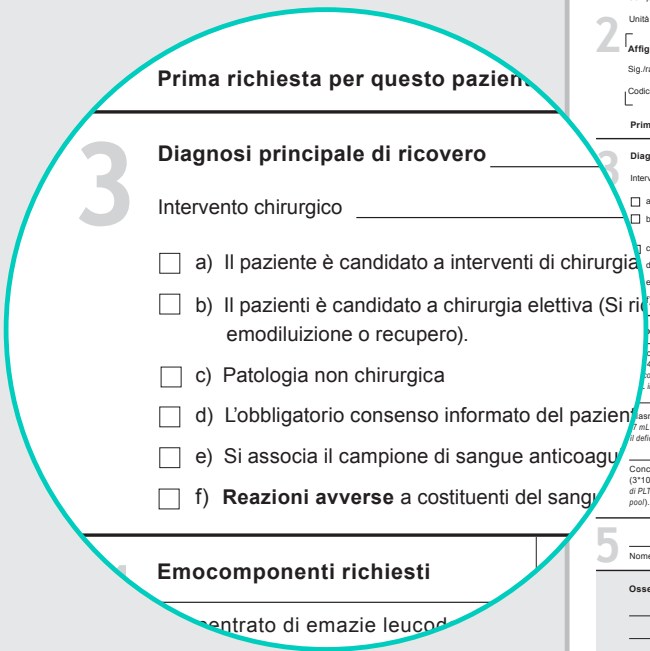
Sig./ra _____
Paziente
izzare etichetta di accettazione per identificazio
o codice sanitario _____ riport

Diagnosi principale di ricovero _____

Intervento chirurgico _____

- Si ricorda l'obbligo di verificare l'attuazione di procedu
nei pazienti candidati a interventi di chirurgia elettiva.
- Si ricorda che per la trasfusione è indispensabile racc
- È richiesto un campione di sangue anticoagulato del
- Se il paziente non è già inserito nell'archivio, verrà ri
all'atto del ritiro delle prime unità da trasfondere.

Emocomponenti richiesti	Numero di unità trasfusionali	Indicazi
Concentrato di emazie depleto (1) Hb)	N°_____	



Prima richiesta per questo pazien

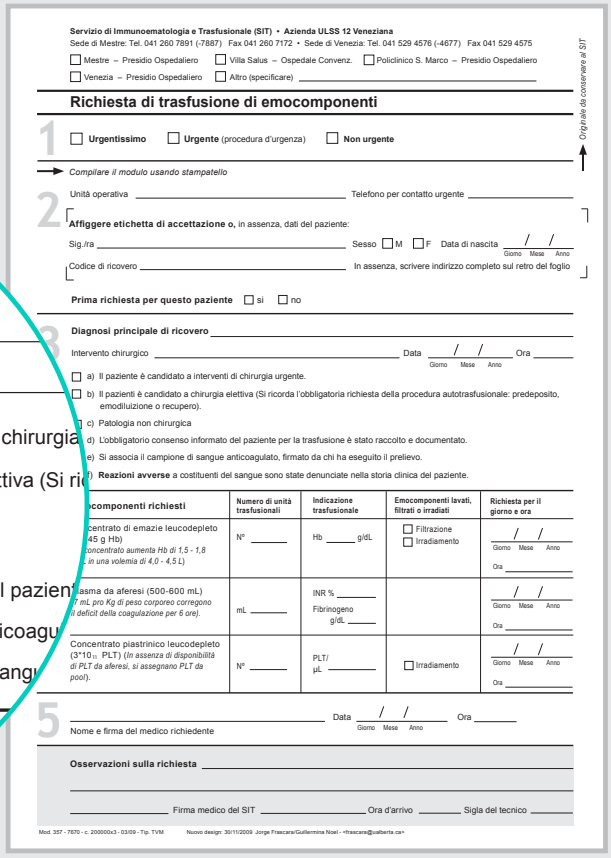
3 **Diagnosi principale di ricovero** _____

Intervento chirurgico _____

☐ a) Il paziente è candidato a interventi di chirurgia
☐ b) Il pazienti è candidato a chirurgia elettiva (Si ri
emodiluizione o recupero).
☐ c) Patologia non chirurgica
☐ d) L'obbligatorio consenso informato del pazien
☐ e) Si associa il campione di sangue anticoagu
☐ f) **Reazioni avverse** a costituenti del sang

Emocomponenti richiesti

entrato di emazie leucod



Servizio di Immunoematologia e Trasfusionale (SIT) • Azienda ULSS 12 Veneziana
Sede di Mestre: Tel. 041 260 7891 (-7887) Fax 041 260 7172 • Sede di Venezia: Tel. 041 529 4576 (-4677) Fax 041 529 4575
☐ Mestre – Presidio Ospedaliero ☐ Villa Salus – Ospedale Convenz. ☐ Policlinico S. Marco – Presidio Ospedaliero
☐ Venezia – Presidio Ospedaliero ☐ Altro (specificare) _____

Originale da conservare al SIT

Richiesta di trasfusione di emocomponenti

1 ☐ **Urgentissimo** ☐ **Urgente** (procedura d'urgenza) ☐ **Non urgente**

→ *Compilare il modulo usando stampatello*

2 Unità operativa _____ Telefono per contatto urgente _____

Affiggere etichetta di accettazione o, in assenza, dati del paziente:
Sig./ra _____ Sesso ☐ M ☐ F Data di nascita ___/___/___ (Giorno Mese Anno)
Codice di ricovero _____ In assenza, scrivere indirizzo completo sul retro del foglio

Prima richiesta per questo paziente ☐ si ☐ no

3 **Diagnosi principale di ricovero** _____

Intervento chirurgico _____ Data ___/___/___ (Giorno Mese Anno) Ora _____

☐ a) Il paziente è candidato a interventi di chirurgia urgente.
☐ b) Il pazienti è candidato a chirurgia elettiva (Si ricorda l'obbligatoria richiesta della procedura autotrasfusionale: predeposito, emodiluizione o recupero).
☐ c) Patologia non chirurgica
☐ d) L'obbligatorio consenso informato del paziente per la trasfusione è stato raccolto e documentato.
☐ e) Si associa il campione di sangue anticoagulato, firmato da chi ha eseguito il prelievo.
☐ f) **Reazioni avverse** a costituenti del sangue sono state denunciate nella storia clinica del paziente.

Emocomponenti richiesti	**Numero di unità trasfusionali**	**Indicazione trasfusionale**	**Emocomponenti lavati, filtrati o irradiati**	**Richiesta per il giorno e ora**
Concentrato di emazie leucodepleto (40-45 g Hb) *(1 concentrato aumenta Hb di 1,5 - 1,8 g/dL in una volemia di 4,0 - 4,5 L)*	N° _____	Hb _____ g/dL	☐ Filtrazione ☐ Irradiamento	___/___/___ (Giorno Mese Anno) Ora _____
Plasma da aferesi (500-600 mL) *(7 mL pro Kg di peso corporeo correggono il deficit della coagulazione per 6 ore).*	mL _____	INR % _____ Fibrinogeno g/dL _____		___/___/___ (Giorno Mese Anno) Ora _____
Concentrato piastrinico leucodepleto ($3*10_{11}$ PLT) *(In assenza di disponibilità di PLT da aferesi, si assegnano PLT da pool).*	N° _____	PLT/ µL _____	☐ Irradiamento	___/___/___ (Giorno Mese Anno) Ora _____

5 _____ Data ___/___/___ (Giorno Mese Anno) Ora _____
Nome e firma del medico richiedente

Osservazioni sulla richiesta _____

_____ Firma medico del SIT _____ Ora d'arrivo _____ Sigla del tecnico _____

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2

figures 1 & 2. Evidence-based design example: re-design of a hospital form.

...access to information is not only useful: it is a human right.

NOW WE HAVE learned that there are users at the end of every design project, and that our design not only has to include in a visually elegant way what the law requires, but it also has to make it easy to understand by the user population. This user population might differ dramatically across all human variations of class, age, gender, knowledge, experience, social milieu and cognitive skills.

We have also learned that access to information is not only useful: it is a human right. When working in health and safety related environments it becomes blatantly apparent that the information not only has to be there, but it has to be accessible, understandable, and actionable. This is the moment at which evidence-based design enters the scene. It enters when designers discover their ethical obligation concerning the right that people have to understand the information that affects them.

WHAT IS EVIDENCE-BASED DESIGN?

In evidence-based design all the important decisions involved in a design process are supported in two ways: either by studies that appear in the literature, or by results from empirical studies purposefully carried out in connection with the project at hand. This second kind of evidence might not produce generalizable knowledge, but it indeed may produce reliable information to assist specific design decisions.

In my own experience, I always begin a re-design project by doing a diagnosis of the current design. This leads me to identify the areas that need improvement. I might or might not use specialized literature to assist me in the diagnosis task, but I certainly need specialized literature to support my recommendations for changes. I learned this from working with psychologist Tom Nelson: after the diagnosis of the problems identified, the next step of any intervention must be the development of a series of recommendations that would guide a future corrective action. These recommendations are submitted to the client and then are implemented after the client's approval. This ensures that clients and their teams have a chance to discuss the recommendations before spending time on the crafting of their implementation. To defend these proposals the recommendations must be supported by evidence, otherwise, if they are presented as opinions, different opinions held by the client might lead to very unproductive processes.

EXAMPLES FROM THE PRACTICE

PHARMACEUTICAL INFORMATION FOR GENERAL PRACTITIONERS

Working on the re-design of a technical document produced by pharmacists for general practitioners regarding the use of pharmaceutical drugs for a lung illness condition, I devised 34 recommendations, partly based on existing literature and partly on interviews with producers and users of the document. For an example, these are three paragraphs extracted from my report to the client that show how recommendations regarding the use of colour are supported:

> "About 6% of healthy adult males (some authors say 8%), have some form of color blindness (Grether & Baker, 1972, p. 71). These people tend to confuse red with yellow and green with white, and in many situations they confuse red and green. The standard colors for danger, warning, and caution are red, orange and yellow respectively. The poor perception of red suggests not to rely on color alone. When designing a color coding system, care should be taken so that the shades (degree of darkness) are sufficiently distinct for people with severely reduced sensitivity for color. If one analyses the US Army-Navy Aeronautical Specification AN-C-56, the scale of ten spectral colors developed by Chapanis and Halsey (1956), and the US Government Federal Specifications II-C-595, one finds that they are examples of sets built in search for a reliable distinction level by all sighted people.
>
> The colors of backgrounds affect legibility. Luckiest and Moss measured the visibility of type on 10 colors of paper, and found that only the 'Fairly saturated yellowish red or reddish orange' showed significant reduction in visibility, and also in reading speed. It seems that accommodation to conditions allows for a rather broad range of tonal contrast between type and ground, although black on white or on light shades of sepia, cream and buff, tend to be preferred (Luckiest and Moss, 1933, p. 25).
>
> The visibility of black type on color ground, or color type on black ground, depends to a great extent on tonal contrast. Miyake, Dunlap and Cureton studied the ability of subjects to correctly respond to a series of brief exposures of black numerals on color paper (1930, p. 340). They found that black type read very well on white, yellow and green (I suppose, a light green), but red and green type on black ground resulted in low legibility scores (Unfortunately the colors are not reported with precision and it is therefore difficult to generalize results). Tests of reading speed show that red print on a dark green background can extend reading time by about 40%. Tonal similarity and hue conflicts are key situations to avoid when planning colored type on colored ground. Color combinations that result in poor legibility cause an increase in regressions, an extension of fixations' duration, and therefore an increase in perception time; they increase fatigue and overall slow down the reading speed." [1]

Among other citations and discussion, the above led to the following recommendations:

> "RECOMMENDATION 29: Color type on color ground should maintain significant light intensity difference to guarantee legibility (approximately 50% perceived reflectance difference). RECOMMENDATION 30: Poor situations such as medium to dark type on black ground can significantly reduce reading speed and should be avoided. RECOMMENDATION 31: Long texts should normally be printed black on white or off-white ground. RECOMMENDATION 32: White type can be used on color grounds as long as the ground is perceptually 50% as dark as black, that

means, equivalent to a 20% black screen. Red has been found to be twice as visible as black in regards to warnings." [1]

This led to decisions about color type and ground for the design of the document, moving away from the original design, where red titles were set on green backgrounds. Fifty sources were consulted and referenced, and 19 interviews with producers and users were held to develop the 34 recommendations that led to the new design. Testing the existing design and the new one with users, the following improvements in performance were found:

"The average time required to complete all search tasks was shorter when using the new design (77 seconds) than when using the existing one (139 seconds).

When attempting to recall the number of sections in the document, no subject was able to do this with the existing design, and all subjects were able with the new prototype.

When attempting to remember the titles of the sections, no subject was able to do so completely, but a higher accuracy was possible with the new design.

Subjects in general found the new design easier to read, and performed faster at search tasks. They also supported the color coding, the color palette, and the colors used for type.

On a scale of 1 to 5, 1 being not easy to use and 5 being easy to use, the existing sheet was assigned an average of 3.3, and the new one 4.75." [2]

ANOTHER EXAMPLE

A BLOOD REQUEST HOSPITAL FORM

A re-design of a hospital form I did with Guillermina Noël can be used as an example to discuss other step in evidence-based design: the articulation of a clear description of the problems found. In our case we found the following:

"1. Lack of information about existing records for the patient.
2. Lack of clarity and completeness of information and requests.
3. Ambiguity in some texts.
4. Inadequate sequence of items.
5. Inadequate layout.
6. Visual and textual 'noise.'
7. Lack of support for the perceptual and cognitive tasks of the users.
8. Lack of possibility to confirm that the user had followed correct procedures.
9. Lack of instructions about how to fill in the form.
10. Inadequate slots for some items to be entered.
11. Important information was buried." [3]

This led to the decision to base our work on three basic criteria: "*correctness* (of the data); *consistency* (in the way requests and information are presented); and *correspondence* (between the needs of the form filler and those of the service deliverer) (Janssen & Neutelings, 2001)" [3].

This in turn lead to the development of *performance specifications*, another necessary step to be covered when designing documents on the basis of evidence. Performance specifications define what the document *must do*, as different from defining how the document *must look*. A document is a tool people use to achieve a given objective. People should be able to use it with ease, efficiency, and accuracy.

In our case, we decided that the form should facilitate:

"1. Reading all texts.
2. Finding any specific piece of information.
3. Following requests properly.
4. Filling in all the items in the form.
5. Transcribing the information.
6. Confirming that procedures and actions have been properly followed.

... As a result of the evaluation and performance specifications, 52 modifications were introduced, focusing on reducing the users' cognitive efforts (Desaulniers, 1987; Frolich, 1986), making their job more efficient (Fowler, 1983) and error free. To achieve this, eight prototypes were designed through an iterative consultation process." [3]

As said before, evidence in design not only emerges from specialized literature, but also from field research developed specifically for the project in question, through interviews, tests and other research strategies involving users.

CONCLUSIONS

Evidence-based design is accountable design. It is a way of ensuring that one is making the best possible decisions by using the information available at the point of creating the design. *Evidence-based design* takes advantage of the hundreds of studies developed in related sciences such as psychology in its many specializations (perceptual, cognitive, behavioural, educational, etc.), the study of language comprehension, anthropology, sociology, marketing, physiology of vision, and any other science that could be relevant to assist in the creation of effective solutions to design problems. Communication design is not centred on the arrangement of type and images (our means as designers), but on optimizing the human processing of visually presented information.

Evidence-based design is responsible design, it does not vary with fads and fashions or with the capricious moods of a designer. It provides a dependable service to society and, as a consequence, positions the design profession among other credible disciplines, where a vast pool of knowledge is combined with sensitivity for the particular demands of specific situations.

Evidence-based design is reliable design, that combines existing scientific knowledge with knowledge created to address the situated nature of every design project.

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[1] Frascara, J. *Information design review project. Phase 2: Project 1. Design criteria and guidelines for the visual presentation of information.* Internal report to client: Submitted to the Alberta Drug Utilization Program. 2006. [2] Frascara, J., and Rueckert, S. Medical communications and information design. *Information Design Journal, 15*(1). 2007. 44–63. [3] Frascara, J., and Noël, G. Evaluation and design of a blood transfusion request form. *Information Design Journal, 18(3).* 2010. 241–249.

Health Design Ethics

NAVIGATING THE INTERSTITIAL SPACE OF DESIGN AND ETHICS FOR HEALTH CARE

Jonathan Aitken
Guillermina Noël
Deborah Shackleton

IN DECEMBER, 2014, the Health Design Lab submitted a "blanket" Ethics Application to Emily Carr's Research Ethics Board (REB) in order to summarize and explain our overall methodology. The goal of this application was streamlining the ethics application process for projects the Lab manages that are very similar in methodology. The following text excerpts some of that application.

BACKGROUND

The Health Design Lab at Emily Carr is committed to providing design opportunities to students and faculty through collaborative partnerships that apply solution-focused, human-centred research methodologies to complex problems in health care.

The Lab typically collaborates with a range of different partners—health authorities, research teams at other universities, private industry, etc. to consider design problems that range from simple product ergonomics, to larger so-called "wicked problems" that require design interventions that could facilitate behavioural or cultural change within a specific environment. What links these projects is their focus on human-centred design to put people at the core of the design and research process.

The aim of this design process is outcome focused. We apply the knowledge learned from a range of research methodologies to specific designs or recommendations for systemic change. These outcomes range from CAD modeled product prototypes to web sites or mobile apps or print based solutions. In most cases, projects are accompanied by a design process book. This book documents the full design and research process, grounding the outcomes in evidence. In some cases, a secondary outcome of the project is a paper, often written by students and/or the faculty lead, which is submitted to either *Current*, Emily Carr's design research journal, or an external publication. Where this is an intended outcome, it is included as an outcome in the participant consent form.

Most projects are funded directly by the partners, but we have also been supported by grants, including the Natural Sciences and Engineering Research Council (NSERC) and the Canadian Institutes of Health Research (CIHR). Where partners are private and outcomes are intended for commercialization, an Intellectual Property (IP) Agreement is included with the Memo of Understanding and all research collaborators and students are made aware of the terms of the agreement. Research participants are also briefed on the potential application to a commercialized product.

METHODOLOGY

While our methodology is by necessity project specific, we draw upon a common set of "tools" and we follow a similar research trajectory for most of our work.

First, a full review of current literature is undertaken to educate the project researchers, to understand the problem, to identify what is known and how it was studied, and to ensure that any existing work is not duplicated. This also encompasses a contextual survey, to see how other research teams or designers have approached the problem space. This literature review is often followed by an exploratory research phase, where we talk to partners and stakeholders informally to gain a better understanding of the problem space. From here, we typically generate a series of research questions and a thesis statement.

To address these questions, we consider how generative research techniques could be applied to gain a deeper understanding of the challenges and attitudes of the stakeholders, as well as developing empathy for users. These methods, largely based on the work of Sanders and Stappers in their seminal work *Convivial Toolbox* (2012), include co-creation activities, focus groups, ethnographic probes, job shadowing, direct observation, user testing, interviews, and surveys.

From the results generated by this "soft" research process, we use an affinity mapping technique to look for areas of commonality from different participants. We group information into common themes. From these themes we create a set of guiding design principles to help inform the iterative stage of our process. This iterative phase can also be inclusive, bringing partners into the brainstorming process. Last we move from iterations through refinement to a prototype design. Where feasible, we re-engage with stakeholders to evaluate the success of the proposed design in user testing.

CURRENT ETHICS PROCESS

Established formally as a research centre in 2012, the Health Design Lab (HDL) has engaged with Emily Carr's Research Ethics Board on many project and course-based applications. From this experience, researchers in the Lab have developed a strong understanding of the ethics landscape, particularly as it applies to design and research for healthcare. This knowledge has proven highly useful, particularly in collaborations with the health authorities, as they have an understandably rigorous process of their own, also based on TCPS2 (*Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans*). Students who are engaged with any HDL project are required to complete the TCPS2 tutorial. But further, all Research Assistants participate in discussions about ethics and learn how to apply their knowledge to their engagements with participants. In all cases, students are closely monitored and supervised by faculty.

PROPOSED ETHICS PROCESS

The HDL is proposing a revised process where the HDL and the REB would agree on a set of protocols that would inform whether a full project-based application is required or HDL would proceed with its own vested authority for simple projects. If all protocols are met, then HDL would be empowered to commence research without a formal ethics submission, and submit all documentation at the end of each project. The following protocols are suggested:

1. Projects that engage adults capable of informed consent participating in activities that are minimal risk (defined as not more than participants would encounter in everyday life) would fall within HDL's scope of approval. These would include:

   A. Co-creation B. Interviews C. Surveys D. User testing

   E. Ethnographic probes F. Observation G. Job shadowing

2. All principles of informed consent to be followed on all projects.
3. HDL faculty will ensure that all project researchers have completed the TCPS2 tutorial, and will take on educating students around ethical practices in research.
4. The HDL Lead Researchers will assess HDL projects for REB protocols and will work with partners, students and faculty in determining the nature of risk and benefits for any given project.
5. Lead HDL Researchers will oversee all projects, ensuring all ethics protocols met.
6. All ethics-related materials (consent forms, model release agreements, etc.) will be delivered to the REB office for safekeeping at the end of the academic year, or completion of the project.
7. Any data will be given to the REB office for secure storage (note, HDL "data" is usually ephemeral and not able to be stored. Such items as sticky notes on kraft paper are reassembled from their original context and destroyed after design principles have been extrapolated).
8. Anymous involving project partners will be forwarded to the ECU REB as they become available.
9. Student and faculty members Core Ethics Tutorial certification will be forwarded to the ECU REB for reference.

Projects that would trigger a full project-based review would include:

1. Those for which informed consent is sought from vulnerable populations such as children (minors) and the elderly (who may have physical or mental impairments).
2. Any activity deemed to be more than minimal risk such as a research inquiry that looks into diabetic self-care management wherein the research participant is asked to divulge information pertaining to diet, medications and exercise. This might necessitate seeking professional mediation by a healthcare practitioner to mitigate the risk.

SUMMARY AND SCOPE OF PROPOSED RESEARCH

1. Rationale

The overarching goal of the work of the Health Design Lab is to apply a human-centred design methodology to challenging problems in healthcare, offering outcomes that have the potential to effect real change within a specific environment. The primary goal of this work is therefore directed towards designed outcomes. These outcomes vary greatly and range across systems design, product design, interaction design, etc. The research that is conducted for this work is undertaken to directly inform the design

process. Our value is in *applying* research to design, in innovation, not necessarily the research itself. Coupled with this service model, is a focus on the educational value of a project to students. Does the work provide a real learning opportunity where students can practice human-centred design methodologies and apply theory to practice. Our work dovetails with courses in research methodologies taught at Emily Carr and we have frequently embedded projects in those, and other courses.

2. Methodology

At the Health Design Lab we use a human-centred and qualitative approach to study health related design problems. Our methodology allows stakeholders to become active participants in the design process. We interact with users and engage with them in discussions, conversations, explorations, evaluations and activities that help us to better understand their views, needs and preferences regarding specific problems, objects and situations.

INTERVIEWS

In asking questions, the designer gains a deep understanding of the problem studied, for example the participants' thoughts, feelings, needs, intentions, attitudes, views and experiences. The designer is an active participant in managing the interview process ensuring that the required subjects are covered, and respecting the participants' views. Most frequently we conduct structured and semi-structured interviews in person, phone or video conferencing.

OBSERVATIONS

Observations enable designers to learn about events, activities, behaviours, and artifacts within their natural environment. Observations provide valuable information such as who interacts with whom, how is the interaction managed, how objects or artifacts are used, when are they used, and for how long. This method usually offers additional information in identifying events or activities that participants may not be aware of at the time. Most observations performed by designers in the Health Design Lab are passive. The participants are aware of the researchers' observation activities, but the researchers are not members of the group studied and avoid disrupting normal activities.

CO-CREATION

Co-creation is the creative act of making, telling and enacting, where designers provides toolkits to participants to interpret ambiguous questions and answer them, to discuss problems, to describe future experiences, concerns or opportunities, to make artifacts or "things," and to create prototypes. These toolkits are collections of physical elements conveniently organized for participatory modelling, visualization, or creative play by users, to inform and inspire design. Ideally participants engage in iterative cycles of making, telling and enacting.

ETHNOGRAPHIC PROBES

Ethnographic or cultural probes provide a way of gathering information about people and their activities. Recipients of the probe are guided through a series of activities that span a time period and probe for people's perceptions. Participants are given a kit of materials, and briefed about the requirements to record or note specific events, feelings or interactions over a day or another period of time.

QUALITY ASSURANCE

Frequently the Health Design Lab engages in Quality Assurance studies. A Quality Assurance or Quality Improvement study aims at monitoring and evaluating services, facilities, employees, or aspects of projects (such as training or best practices applications) to ensure that standards of quality are being met. The study requires data collection and data analysis but, since this information is used to assess an organization's performance, or the relevance or success of programs and projects, the study does not require Research Ethics Board review. The results are used to improve, redefine, or redirect future objectives and activities. Generally, results of quality assurance studies are not for public release.

EXPLORATORY RESEARCH

Most of the research done at the Health Design Lab uses qualitative methodologies. Occasionally, researchers start with exploratory work before conducting the research to understand the main aspects of a problem or community they need to involve in their research. These explorations are open-ended. The aims are: to gain understanding rather than describing phenomena in detail, and to allow designers to become familiarized with situations, cultures, norms, or communities. The results allow designers to discuss the suitability of the research, consider possible collaborative partnerships, consider access to settings and populations, and to plan the research proposal (determining research question, methods, sample size, and data analysis). Research activities might include dialogues, passive observations, taking notes, and writing a diary.

PARTICIPANTS

Our research involves diverse groups of patients, healthcare personnel and administrators, older, younger, differently able, and multicultural populations. We select participants according to the scope, objectives, nature, and context of our research, as well as on the existing knowledge about the problem studied. When working with vulnerable populations we seek the advice of experts.

RECRUITMENT

Frequently, recruitment is done through our partners given that they have easiest access to participants. Through dialogue with the partners we ensure and discuss the issues around voluntariness. During the consent process we make it clear to participants that they are free to withdraw their consent to participate at any time and without providing a reason.

BENEFITS TO PARTICIPANTS

Our research produces benefits that may contribute to the care, treatment and well being of the participants and other members of society. Benefits to participants very from project to project, and might include: taking an active role in one's own healthcare, helping combat feelings of helplessness, doing something interesting, talking with people that suffer from similar conditions or are in similar situations, exercising one's autonomy and taking active role in society, and gaining understanding and ideas to improve one's own condition, well being or quality of life.

Learn more about HDL at www.healthdesignlab.ca

Victoria Lee

UPLYFT

Connecting People with Primary Lymphedema

I WAS BORN with primary lymphedema (PL)— a rare, congenital, progressive and chronic swelling affecting primarily the limbs, leading to distortion in size, shape and even function, in my left arm and intestines. PL is caused by a failure in the lymphatic system and contributes to an individual's physical, social, emotional, and psychological distress. Furthermore, without a normally functioning lymph system, non-reabsorbed fluid, protein, cells, and fat remain in the system and can cause death within 24 hours [2]. Medical care tends to place emphasis on the physiological affected limb while little attention is placed on improving one's social, emotional, and psychological well-being [2].

As a young adult who has grown up with this condition, I have found that even with the support of my medical care team and close friends and family, my condition has strongly affected me emotionally, psychologically and socially—especially in relation to how I perceive and identify myself in regards to my body image. Secondary and primary qualitative research revealed that many individuals experience and cope with social stigma, which has been key in the construction of their narrative identity [1]. They are "left untreated, unsupported, and suffering unnecessary psychological distress" as the swelling is seen as a constant reminder that there is something wrong with them [2]. In addition, many feel too apprehensive to talk about their stressors and seek acceptance, thus resulting in feelings of isolation [3].

SHIFTING TO BRIGHTER NARRATIVES

PL is considered a rare condition with affected individuals scattered across the globe; these individuals have voiced the need to share their stories with others with the same condition. My undergraduate thesis project, Uplyft—the name deriving from the benefits of elevating the affected limbs and the spirits of those with PL—has become an opportunity to respond to this problem space. Uplyft is an online community for young adults between the ages of 20-35 diagnosed with PL, where they can share personal stories, build online and local communities and connections, and discover available support groups. The aim of this community is to shift its members' self-perceptions through storytelling.

STRATEGIES HAPPENING TODAY

Current approaches that strive to provide a sense of community for these individuals are social networking platforms such as Facebook groups, which act primarily as spaces to share knowledge about maintaining physical health. There are also online forums where users read and post questions and answers about lymphedema topics. However, young adults who are ready to speak up about their stories feel Secluded. There are few spaces that respond to their age group where they can share concerns relevant to their experiences (Primary Participant 1, personal interview, November 2, 2014). In addition, most of the discussion topics are about secondary lymphedema because most of the active members are affected by this condition (Primary Participant 1, personal interview, November 2, 2014). Blogs are the most effective precedence thus far, as they serve as online diaries for users to post their daily experiences while other users can get a more intimate understanding of their stories by reading, commenting, sharing and favouriting posts.

DESIGN OPPORTUNITY

Providing an online space for connection emerged as a clear design opportunity. After exploring a variety of solutions, I focused on the design of a responsive website where these individuals can share personal stories, build connections through online and local communities, and discover available support groups at any point of their day. I have established three design mandates that must be present in the final outcome in order to successfully shift the primary user's perceptions about their body image and appearance:

1. Reduce feelings of isolation by generating a sense of community
2. Provide accessibility to those in remote areas
3. Educate the general public about PL

DESIGN IMPLEMENTATION

Uplyft's home screen mirrors the interconnected lymph system by joining the isolated worlds of individuals into an immersive connected visual galaxy. Within this space, by panning, zooming and tapping, users are able to explore other peoples' stories and hobbies, and also see who they're following or are followed by. Users can share their written stories and related media content with a customized user group or open them to the public. They're also able to directly message each other and members of the Uplyft staff, add users to their following list, and locate available support groups to generate a stronger sense of community. By providing a community space where young individuals with PL can share their personal stories and generate dialogue, Uplyft is an opportunity to shift their self-perceptions of their body image and appearance.

figure 1. Screens from Uplyft application, a tool to connect primary lymphedema patients.

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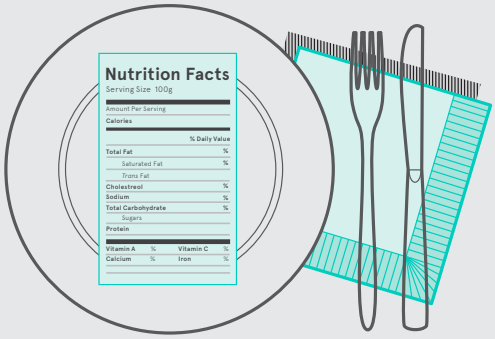
April Piluso

DECODING THE RESTAURANT

Addressing Nutritional Values of Prepared Foods



THE BRITISH COLUMBIA ministry of Health has established a program called *Informed Dining* (ID), which seeks to help restaurants provide nutritional information for prepared foods. Administrative staff have identified a need for people to more easily access this information. Emily Carr University of Art + Design students were asked to help. Our team used interviews, ethnographic probe kits, and competitive analysis to gain a full understanding of the problem; this research led to insights that had been overlooked by project partners, giving us an opportunity to add value to the project. We discovered that numerous potential target groups already track food intake through other smartphone apps, creating an opportunity to push and pull information between apps to give people a clearer understanding of their eating habits. Our team has recently started the development of a clickable, working prototype that addresses these issues and opportunities.

BACKGROUND & CURRENT LANDSCAPE

The ID program is an ongoing project initiated throughout the province by Healthy Families BC—a province-wide health promotion initiative—in early 2012 [3]. The program seeks to work with restaurants, cafés, and other dining establishments to provide nutritional information for meals prepared by these businesses. The goal of the program is to provide BC diners with the tools required to make informed menu decisions, giving them more control over and confidence in their meal selections [3].

With more than 2,000 restaurant outlets participating in BC and 10,000 nationally, the program is gaining momentum with restaurant participation. This increase, however, has not influenced user participation, which continues to grow much slower than anticipated. Since the program's inception, one challenge has been to provide restaurant customers with adequate tools to interpret the nutritional value of prepared foods. The program currently employs a series of printed material, ranging from brochures to booklets. It has been determined that these materials are not convenient for people who need a faster, more accessible method of accessing food information.

RESEARCH

We were asked to create an app to help deliver nutritional information to people in a fast and accessible manner, focusing on a predefined user group of women aged 25–45 with families.

On the Canadian government's Ministry of Health website, we found charts, diagrams, and other information that outlines the nutritional value labeling system, which is used by the ID program in their print materials [2]. We next investigated Denmark's approach to providing nutritional information. Their Ministry of Food, Agriculture and Fisheries outlines a keyhole labeling system that was initiated in 1989. The keyhole symbol, found on pre-packaged foods, acts as a quick reference to help consumers make healthier decisions [1]. We compared this information to what we found on the Canadian government site.

We also referenced IDEO's Human-Centered Design Toolkit. This toolkit provides an in-depth overview of many research and design techniques that work in tandem with stakeholders to produce holistic and human-friendly solutions [4].

We then visited participating restaurants in the Vancouver area to make on-site observations. At the end of each visit, we collected available information pamphlets for further investigation and reflection.

We decided that the pre-defined target group of women aged 25–45 with families omitted significant groups who could benefit from this service. We determined nine other potential user groups. Of these groups, we identified three that would benefit most from the use of the app: bodybuilders, dieters, and mature adults with health conditions. We added these three additional personas to our research. This determination allowed us to focus our data gathering on those who could provide us with the best insights.

We next familiarized ourselves with the mindset of these particular groups of restaurant patrons; we wanted to better understand their existing realities, needs, wants, and desires. To do this, we generated ethnographic probe kits with six activities that lasted over a period of one week and that questioned our participants on the topic of eating prepared foods. The activities asked participants to keep a food journal for a week; to recall a dining experience and mark out positive or negative events on a short timeline; to look

back over the past two weeks and mark on a map the places they had eaten; to indicate where they might want to see nutritional information in restaurants; to play a guessing game to see if they could accurately gauge the caloric content of a meal from a photo alone; and to consider a series of reflective questions the next time they were at a restaurant. While our goal was to distribute these kits to the public who matched our target group criteria of bodybuilders, dieters, and mature adults with health conditions, due to time constraints, we were limited to asking people we knew personally (friends, family, and fellow Emily Carr students) who fit these criteria.

To gather additional information, we interviewed general practitioner Dr. Denise McLeod, owner of the McLeod Family Medical Clinic. This discussion gave us a better understanding of which nutrients matter most to a person's well-being, and how doctors use this information in their medical practices (D. McLeod, personal interview, November 2, 2014).

Next we conducted a competitive analysis of several apps that provide nutritional information. The apps we chose to analyze were Argus, Moves, SparkPeople, Edomondo, Fitbit, and MyFitnessPal. As we used the apps, we noted each app's ability to convey information clearly, function simply, be visually dynamic, and provide an overall pleasant user experience.

PARTICIPATING RESTAURANTS

We found that partnered establishments did not widely advertise the availability of nutritional information; many of the restaurants did not prominently display the ID signage. As well, existing nutritional pamphlets and booklets were made available only upon request or at the till, making the process inconvenient for most customers. The printed information itself was not laid out in an approachable or accessible manner. We also discovered that some staff members were not aware of their business's participation in the program, leading us to believe that the ID initiative is of peripheral concern to some of these establishments.

RESPONDENT INSIGHTS

Responses gathered from the ethnographic probe kits indicate patterns in participant thought processes. We noted that people, while interested in having nutritional information available, are unwilling to go to great lengths to retrieve that information; they do not want this service to interrupt their dining experience. We also found that although people make meal selection based primarily on food images and descriptions, they are unskilled at accurately estimating nutritional content using this information alone. Additionally, responders expressed an interest in having information available in a way that allows for casual, pre-emptive decision-making. Several of the target groups already use smartphone apps to track their food intake, often in relation to already established food-related goals, which gave us an unexpected opportunity to explore.

CONCEPTUAL DEVELOPMENT

First, we laid out all of the information we had gathered, including the client's desires and needs of the target users, and grouped similar findings and information together. Next, we took these ideas and arranged them hierarchically according to our stakeholders' priorities. We came away from this exercise with a list of primary concerns to address:

figure 1. Six activities in the ethnographic probe reveal the thoughts of restaurant patrons and their customers.

figure 2. Informed Dining application. Screens from the final prototype.

- The information must be easily accessible, ideally having at-a-glance info with an option for a more detailed view
- The information must be easy to understand; data visualizations should be used to simplify and make tabular data
- The information and food selection criteria should be presented hierarchically to reduce cognitive load; this hierarchy could relate to the user's unique goals or limits
- The app should give the option of searching for nearby restaurants, highlighting those participating in the ID program
- Where applicable, the app should be able to push and pull food-related information to and from similar apps on a user's smartphone
- The app itself should be friendly, providing the user with moments of delight to enhance the user experience and promote future use and interaction

After determining what was needed within our app solution, we then produced physical mockups. Creating paper prototypes before moving to a computer environment gave us something tangible to present to testers, to see if they understood the basic flow of the proposed system, while allowing us to remain in a revision headspace, unattached to a final solution. Feedback concerning our existing grid layout, features, and accessibility avenues informed changes we incorporated into the third iteration of our paper prototype.

Having completed final testing on this prototype, we are now prepared to address the visual design of our app. Our project partners at ID provided branding details for use in our visual design. While some of the colours and typefaces are suitable for printed material, certain design decisions must be made to ensure the final visual aesthetic for the app remains approachable, friendly, and legible. Analyzing and restructuring problem areas of the brand guidelines to apply to mobile devices will be addressed in the near future before final high-fidelity mockups are made.

COMMENTARY

The use of co-creative methods and iterative design—allowing ideas to diverge and converge multiple times with the help of the people we are designing for—has greatly influenced our project's development. We find ourselves with a far more refined and considered solution than what we would have been able to develop on our own. An additional benefit of co-creation is that the final design is more likely to be suited to the overall system and its users [5]. The value our solution intends to deliver extends from providing nutritional information to assisting with the bigger picture of a person's overall well being. The processes our project entailed demonstrate that, in the end, the product itself is not significant—the worth of the product lies in the value it can add to the lives of those who use it.

ACKNOWLEDGEMENTS

I would like to thank those who have contributed to this project: my project partner, Helena Levison, for her unique way of thinking and her gift of curiosity; my instructors, Haig Armen and Eugenia Bertulis, for their guidance and patience; and our project partners at Informed Dining, Heather Bretschneider, Lisa McKeller, and Regan Hansen, for the opportunity to work with them on a provincial initiative.

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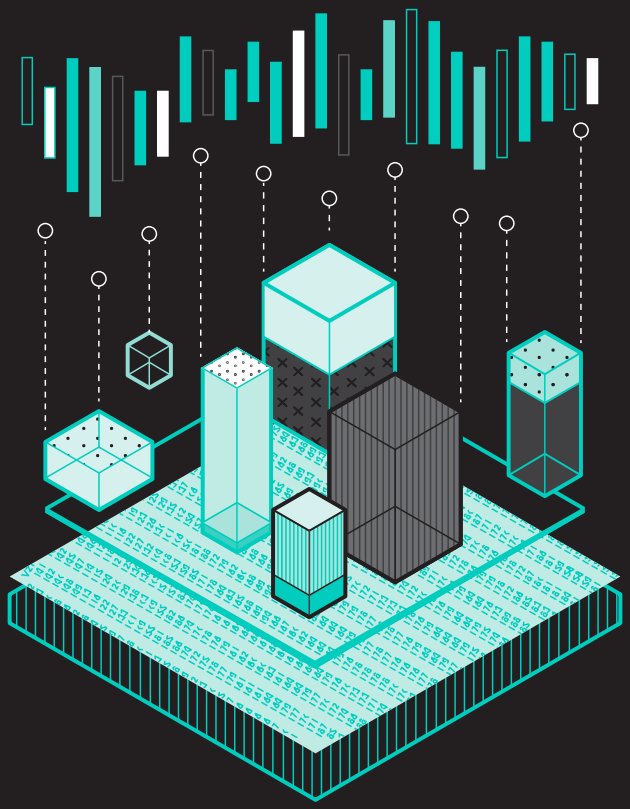

studio for extensive aesthetics:

AN ARTISTIC RESEARCH LAB AT EMILY CARR

Amber Frid-Jimenez

THIS PAPER DESCRIBES the research and theoretical orientation of the Studio for Extensive Aesthetics (SEA), which produces projects and artistic research on the aesthetic implications of technological innovation. Particularly, the studio investigates the aesthetics of the growing archive of cultural data and information produced by global networked infrastructures. The work is transdisciplinary in nature, operating through artistic and computational means. The studio is co-located with the Graduate Studies programme at Emily Carr University of Art + Design and engages art and design students with a network of international theorists and practitioners through research projects at various scales, from screen-based work to urban scale installations. The studio is funded by the Canada Foundation for Innovation, the British Columbia Knowledge Development Fund, and the Canada Research Chair programme, a federal organization that provides research positions for scholars across the sciences and humanities. I established the studio in 2014, when I was awarded Canada Research Chair in art and design technology.

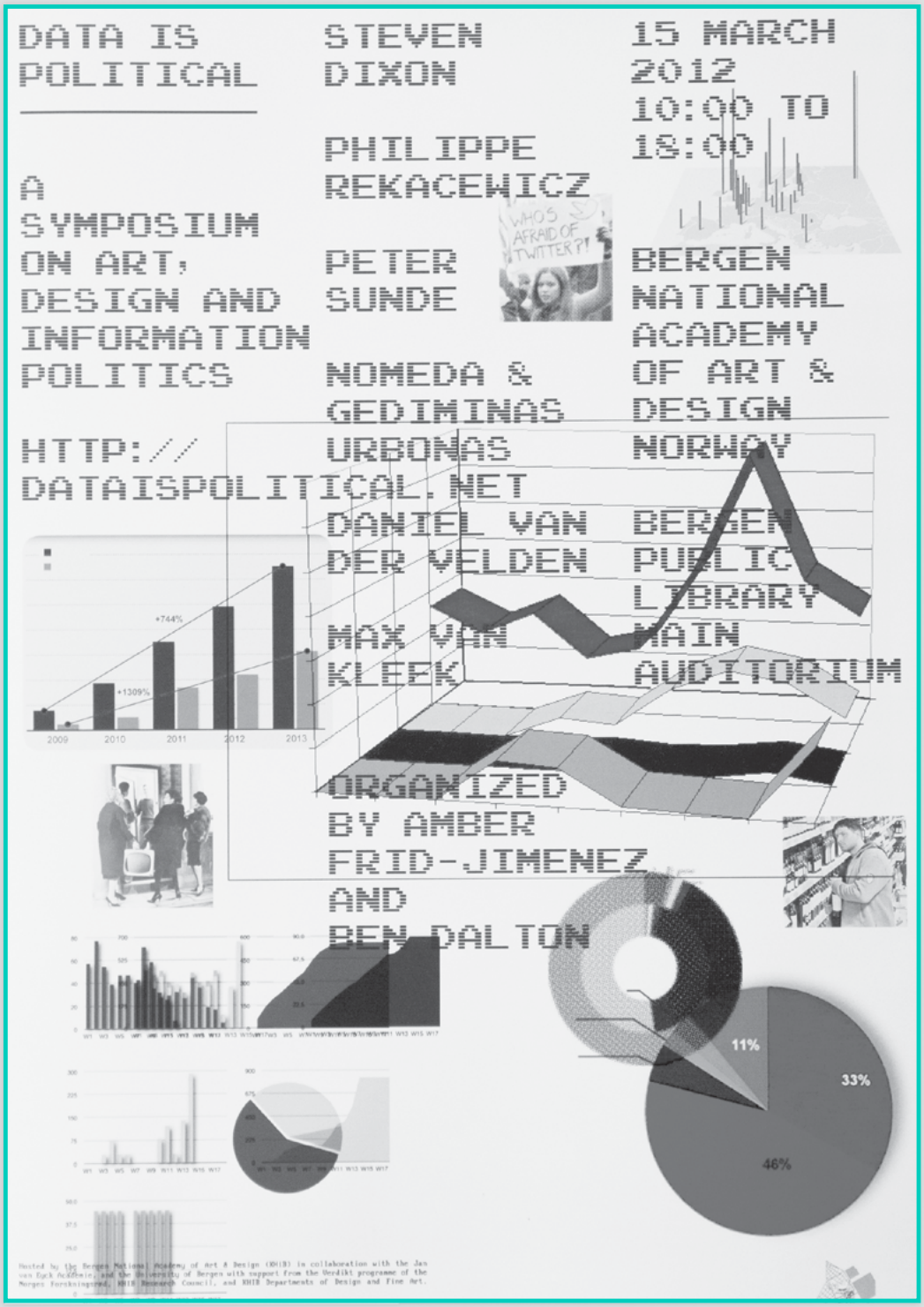

figure 1. *Data is Political: A Symposium on Art, Design and Information Politics*, organized by Amber Frid-Jimenez and Ben Dalton. Bergen Public Library. Bergen, Norway, 2012. Poster design by Ina Kwon.

ONE AREA OF particular engagement at the SEA is data aesthetics and visualization. Data visualization is a fundamental tool in advanced societies, which rely on ever-increasing data flows since the transition to the digital era. Nearly every aspect of contemporary life is informed by a vast array of data collected by governments, corporations, scientists and individuals. Massive amounts of complex data lead to a signal to noise problem: using data effectively requires interpretative tools that render the data intelligible to human decision makers. In the past two decades, data visualization has emerged as an effective method of seeing meaning within large data sets. "Visualization" refers to representation in many forms, from graphs and other visual tools to sonification or haptic interfaces, but in general visualization helps make data comprehensible to humans. From mobile applications that use trends to advise purchasing decisions, to medical devices that provide real-time predictive assessments of patient conditions, data visualizations increasingly exert explicit or implicit influence over contemporary decision-making across disciplines and contexts.

The SEA engages directly with the methodology of data visualization to question the discipline. An effective data visualization depends on many related factors, including the attributes of the data collected, the interpretative algorithms employed, the chosen method of visualization, and its aesthetic aspects. Among these, the aesthetic component, which comprises both the visual aspect of the visualization and the emotional response that it engenders, has a profound effect on the way data is interpreted by a viewer and is among the most important to the overall effectiveness of communication. At the same time, the aesthetic dimension of data visualization has attracted comparatively little attention to-date and is one of the least understood by scholars, due in part to the difficulty of defining the role of aesthetics in conventional terms. As data visualization becomes a mass medium, understanding its aesthetic dimension is paramount. The research required to build knowledge in this area is transdisciplinary by nature, requiring the ability to merge traditionally disparate fields of computer science and the arts. Drawing on the fields of art, design, aesthetics, and computer programming, the SEA contributes to the growing body of research on this topic.

The shift to the constant use of data in mainstream culture makes it vital to recognize the power dynamics surrounding collection, aggregation, ownership, and visualization of large data sets. Michel Foucault's assertion that knowledge is power that cannot be exercised neutrally is reflected by Melvin Kranzberg's statement that "technology is neither good nor bad, nor is it neutral" [7, 14]. These perspectives, which have been picked up more recently by Eli Pariser and Philippe Rekacewicz, and Marian Dörk, inform my understanding of the relationships of power and control surrounding data and its use [17, 18, 5]. Institutions with the resources to house and process massive stores of dynamic data do so from within particular socio-economic contexts and cannot therefore be neutral. Through research and artistic projects, the SEA highlights these issues in contemporary culture.

The SEA exists at the intersection of art, design and scientific inquiry. It is based on a multifaceted approach that incorporates traditional scholarly research in collaboration with leading scientists, and artistic works in collaboration with industry, civic organizations, and cultural institutions. The SEA explores three primary topics pertaining to data:

- The role of aesthetic considerations in the function and affect of data visualization
- The cultural implications of data collection, ownership, and display
- The use of data-driven creative artworks that engage a wide public in reflecting on and rewriting information culture as a collaborative affair

Data visualization is becoming increasingly pervasive and influential with the rise of big data. Understanding its aesthetic and cultural implications will be crucial to making sound decisions about its uses and informing the growing number of people it affects. The SEA generates knowledge within the academic context, while experimental creative projects express that knowledge in a broader social context, engaging the public in dialogue about the data-driven interfaces that play a major role in contemporary culture.

CONTEXT

Two primary areas of inquiry inform the work of the SEA: scholarship on data visualization techniques, and the work of conceptual and media artists and theorists addressing the cultural implications of data collection, ownership, and display. The majority of scholarly literature on data visualization addresses its technical aspects, focusing on areas such as optimization, key problems of image recognition, and new techniques for visual representation of large data searches, generally with an aim of increasing efficiency and effectiveness of data interpretation [6, 3]. This approach has made valuable contributions to technical knowledge, but it offers at best an incomplete understanding of data visualization, which largely ignores its aesthetic and cultural implications. My interest in this underrepresented area of research led to founding the SEA to use research and artistic projects to investigate the aesthetics of data and its cultural implications.

Role of aesthetic considerations in the function and affect of data visualization

Although small in comparison to efforts dedicated to understanding efficiency and optimization, a growing body of scholarly literature and creative work attempts to formulate a rigorous understanding of the aesthetic considerations of data, drawing from the disciplines of computation and design. In the past decade, computer scientists such as Martin Wattenberg and Sheelagh Carpendale have noted the important role aesthetics and semiotics play in human perception of data visualizations [23, 4]. Meanwhile, media theorists such as Alexander Galloway, Warren Sack and Meredith Hoy, and

Data visualizations increasingly exert explicit or implicit influence over contemporary decision-making across disciplines and contexts.

designers such as Victoria Vesna and Lev Manovich speculate on the impact of data aesthetics on visual culture and contemporary art [12, 20, 13, 21, 15]. Recent inquiries into the aesthetics of computational visualization rest largely on foundational work done by Muriel Cooper at the MIT Media Lab, where the Visible Language Workshop investigated the user experience of information from a graphical perspective, creating new computational environments in which data could be experienced in new ways by users [19]. This work influenced later data designers who targeted discovery in the social and hard sciences by using visual metaphors. These include Ben Fry, whose technically accurate interactive visualizations helped scientists analyze the human genome [11]. Fry collaborated with Casey Reas to develop Processing, a visually-based programming language that has extended the abilities of information designers. Fernanda Viegas produced influential visualizations of activity on Wikipedia, translating editing activity into topographical landscapes [22]. With few exceptions, the most significant contributions in the aesthetics of visualization over the past two decades have been made by researchers with the ability to merge the disparate disciplines of computer science and design.

Cultural implications of data collection, ownership, and visualization

The work of conceptual and media artists contains valuable lessons that can be applied to produce a nuanced understanding of the cultural context of data visualization. Contemporary media artists have built on the work of early conceptual artists such as Joseph Beuys and Hans Haacke in innovative ways, applying technically adept visualizations to produce aesthetically compelling artworks that engage with cultural, social, and political issues. Kynaston McShine's seminal exhibition entitled *Information* exhibited at the Museum of Modern Art in New York in 1970 was the first of its kind to take the structures of information, and its display and distribution as the subject of artistic inquiry. More recently, tactical media artists Tad Hirsch and Trevor Paglen use visualization techniques to question the treatment of political detainees by the US military and environmental impacts of industrialization. Information artist Ryoji Ikeda's *Test Patterns* convert audio signals into objects and landscapes, translating normally abstract data structures into tactile environments that create a visceral aesthetic experience. Similarly, Metahaven, the Amsterdam design studio of Daniel van der Velden and Vinca Kruk, develops unsolicited branding and marketing strategies to interrogate cultural data trends such as Wikileaks, using techniques that range from physical artifacts to web-based visualizations. In some cases, the contributions of media artists extend beyond cultural issues to influence the development of technologies themselves. In notable examples such as Xerox's Palo Alto Research Center, an influential innovation lab where early physical interfaces such as the mouse were developed, the creative explorations of artists-in-residence and creative technologists such as Natalie Jeremijenko and Stuart Card played a role in technological development [2]. Collectively, contemporary media artists use data visualization in new and original ways to create aesthetically compelling, technologically adept artworks that offer valuable perspectives on data visualization and the cultural questions surrounding its use. These works engage viewers and participants in a collective discussion about the role of data, information flows, and structures that increasingly define our society.

METHODOLOGY

Work at the SEA follows a cycle that includes preliminary research, prototyping virtual platforms and physical artifacts that are shown in public spaces or galleries, and communicating research results. This iterative design process revolves around praxis, which can be described as the joining of making and theory. The practice of ideas through experiential projects is ideally suited for investigating the aesthetic and cultural dimensions of data collection, distribution and display. Material and visual inquiry offer unique insights that augment and extend knowledge gained through analysis and writing. A multivalent approach that combines both material and visual investigations with writing offers contributions that extend beyond scientific analysis and current data science fields.

The Studio for Extensive Aesthetics creates exploratory data-driven online platforms and physical art and design installations that yield insights into the technical function and cultural use of data tools and methods. Engaging with reflexive questions, studio research addresses issues such as data ownership and inherent bias, as well as the larger cultural implications of living in an age defined by real time streams of information and global sensor networks.

CONTRIBUTION TO KNOWLEDGE

Fundamental changes have occurred in visualization in the past two decades due to the rise of processing power coupled with data collection on an unprecedented scale. With the rise of big data, contemporary data visualization increasingly functions as a mass medium, merging visualization with interaction design to influence lives online and off. The significant opportunities as well as danger of misuse make it imperative to study the aesthetic aspects of data visualization. Understanding these questions requires an original approach that draws from disparate disciplines of art, design and computer science in equal measure.

The Studio for Extensive Aesthetics produces art works and research that engage specialists and the general public in dialogue about the role of data aesthetics in contemporary culture, rewriting information culture as a collaborative affair. Initiating public dialogue about the role of data aesthetics is especially critical in our contemporary society, which is increasingly defined by data collection, screens and information flows.

figure 2. *La Lucha Sin Fin #1*, a video installation by Amber Frid-Jimenez. Jan van Eyck Academie, Maastricht, Netherlands, 2012.

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Exploring the Verso Engine

A 2D PHYSICS DEVELOPMENT PLATFORM FOR MOBILE INTERACTIVE CONTENT

Celeste Martin
Adam Cristobal

INTERACTIVE EBOOK APPLICATIONS continue to rapidly grow not only in sales but also into a sophisticated design discourse that has begun to establish best-practices of user experience design. These practices, however, are always in flux. As early as 2002, researchers defined "Electronic Textbook Design Guidelines" and suitable gestural affordances for an ebook learning environment [7]. Yet publishing processes since then have radically shifted not only in production methods and tools, but also in the relationship between authors, designers, editors, and developers. From a traditional linear model of authorship, editorial, and design, the publishing process continues to shift to a "seamless intersection of the written word, visual design, cinematic storytelling, educational multimedia, and game mechanics" [5]. This shift is still in process, and has enabled designers to define a textual artifact beyond form and into the very parameters of engagement to such an extent that the designer might be considered a co-author of the text [8].

Within the confines of this project, designers were the prime originators and instigators of the artifacts, and worked either with existing texts or primarily visual material. The key collaboration in this process between is designers and developers. In this particular scenario, designers embraced authoring and editing roles, in a process that shares similarities with video game design and development.

PROJECT OBJECTIVE

The objective of this project was to further refine and expand Loud Crow's mobile and tablet application development engine, Verso. Loud Crow Interactive is a leading agency in the creation of children's content for mobile platforms. Their 2D physics engine allows readers to manipulate objects on the screen with highly realistic physical effects. Although they have eschewed the *ebook* term in reference to their work, and have only just abandoned codex metaphors in their design language within the last three years, Loud Crow's products can be understood as enhanced

ebooks for children's fiction. Our research on expanding the Verso engine's applications implicated the exploration of genres beyond children's fiction and into lookbook catalogues, elementary school textbooks, and illustrated adaptations of long-form literary fiction. More importantly, the prototypes produced in this project allowed us to use the affordances of this engine to produce different and enhanced ways of navigation and participation.

FRAMEWORK

This project uses design frameworks that eschew the notion of gamification in favor of playfulness and play in order to deepen user engagement with a given text. As Johanna Drucker has suggested, "sustained interpretative engagement, not efficient completion of tasks, would be the desired outcome" [4]. This is the goal of the interfaces designed in this project. But how can play be achieved without gamification?

Gamification, as defined by Detering et al., is "the use of game design elements in non-game contexts" [3]. The authors derive their definition from Caillois's concepts of *paidia* (play) and *ludis* (gaming); the former being "the uncontrolled play with aspects of improvisation, exuberance and carefree gaiety," and the latter being "playing structured by rules and competitive strife toward goals" [3, 6]. Gamification—for the purposes of this project—therefore implies the implementation of structured play. This project favors the use of play to facilitate "exploratory tendencies" and intrinsic motivations that are "inherently satisfactory," as opposed to extrinsic motivations such as points in a structured game [6]. Rather than modeling the user of these prototypes as a completer of tasks, the user of these prototypes should be understood as performers that engage not only to understand the meaning of the text, but also to shape and reveal that meaning.

The prototypes in this project suggest that the interactive affordances of a 2D physics engine can help users shape the meaning of a text for themselves, but do not altogether define a clear cut solution. Indeed, Colombo and Landoni note, "technology now provides support for enriching ebooks with multimedia content and interactive elements, however it is still unclear how these enhancements can effectively support leisure reading" [1]. Leisure reading is a playful activity driven by intrinsic motivation, and this project seeks to facilitate this particular kind of motivation via three dimensions of reading as established by Wigfield and Guthrie: curiosity, desire for a challenge, and involvement [1]. As such, this project addresses a particularly pertinent question in the discourse surrounding contemporary ebook design: are interactive affordances effective facilitators of intrinsic motivation?

METHODOLOGY

Three individual ebook prototypes were developed as part of the project, and three undergraduate research assistants were involved in their design. Prior to production, several collaborative sessions were conducted with Loud Crow Interactive in order to review the content and objectives of each prototype. As an exercise in user experience design, these collaborative sessions reviewed possible texts for content and examples of navigation and participation from existing products. After these sessions were complete, an individual design brief was developed for each prototype. These proposals outlined the content, goal, scope, visual target, and overall user experience of each ebook. Following the presentation and review of these proposals in collaboration with the Loud Crow team, we moved into later stages of user interface design and production. Production spanned a total of approximately ten weeks.

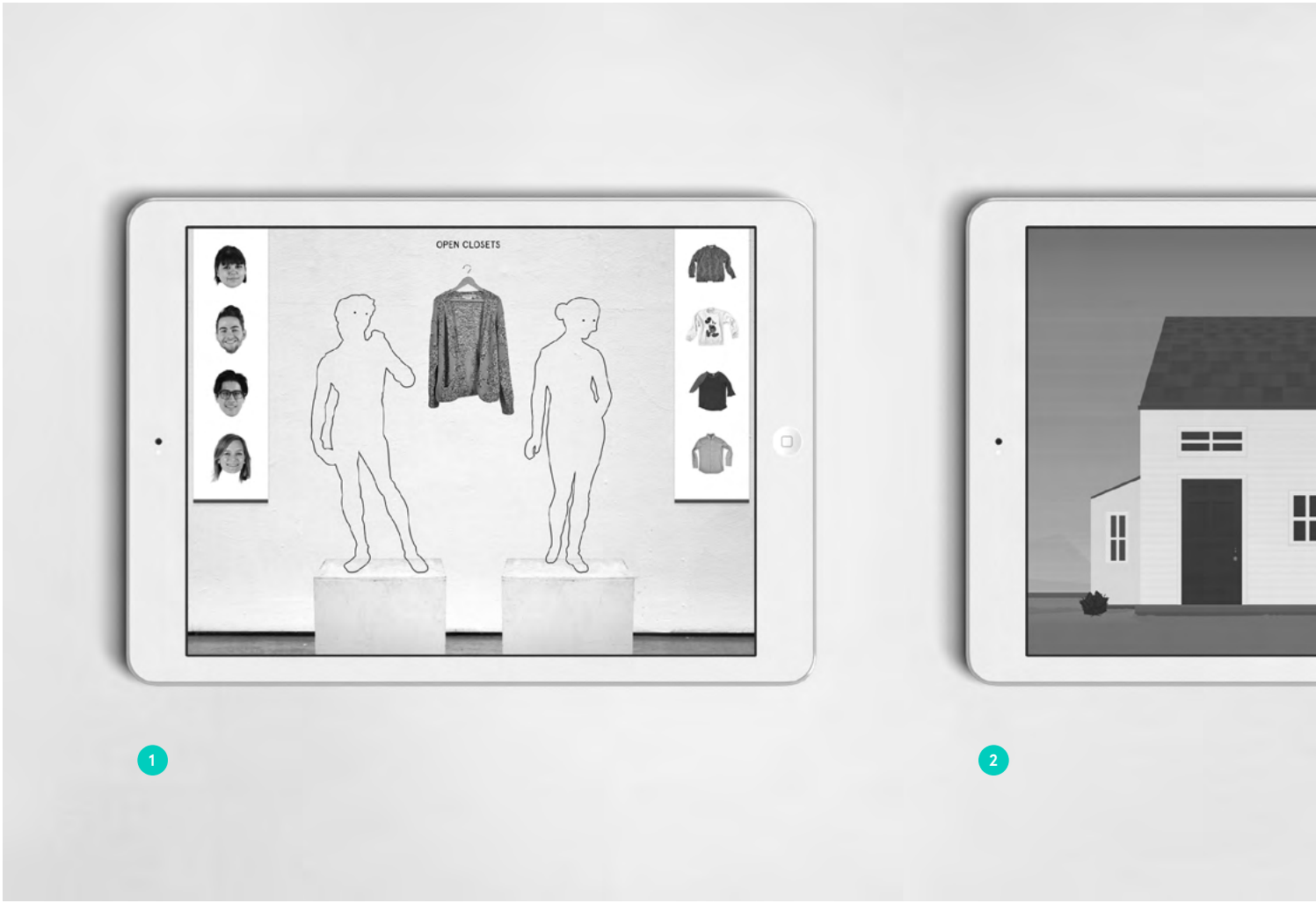
Generally, the Verso engine's production workflow is a three-step process. First, application interfaces are rendered, compiled, and animated in Adobe Flash. This Flash file generates an XML Document Object Module (XML DOM) that defines the interface structure as indicated by the designer in Flash. Next, both scripters and designers append CSS and JavaScript files to the XML DOM in order to implement touch and gyroscope interactivity to the interfaces. Finally, the compiled files are outputted for iOS and Android via Xcode.

OUTCOMES

Three working prototypes were produced for iOS: *Open Closets Lookbook*, *The Red Pony*, and *Fish Families*. *Open Closets Lookbook* is a screen-based interactive catalogue that rethinks the function of the lookbook: a standard in the fashion industry. *The Red Pony* draws on the content of John Steinbeck's novella of the same title and enables users to explore a virtual rendering of the Salinas valley farm, the story's primary setting. *Fish Families* is a non-fiction ebook app for elementary school-aged classroom users to explore a virtual ocean and learn about family structures in marine life. With Drucker's goal of sustained interpretive engagement rather than a mechanistic, task oriented approach, each prototype uses alternative navigation structures and modes of user participation in order to facilitate a sense of play [4]. The Verso engine becomes a tool that supports affordances for play and, as Knaving and Björk have suggested, "make interacting with the activity more effortless and fun and hopefully allow the user to find and develop intrinsic motivations related to the activity" [6]. Here, interfaces supported by the physics engine ask users to engage in play by taking an active role in storytelling within each prototype.

Open Closets Lookbook (figure 1) is similar to a paper doll dress-up activity within the context of a communal closet system: two models at the center of the screen are flanked by pieces of clothing that are dragged onto the stage. Different combinations of clothing trigger a variety of photographic or video surprises that visualize the collective ownership of each garment. Users are asked to discover relationships between the closet participants, and thereby play a more active role in the lookbook's social and sartorial narrative than usually afforded by print catalogues. Here, users actively engage with the concept of shared clothing, and experience the products and concept itself rather than a static representation.

The Red Pony (figure 2) harnesses the episodic writing of the Steinbeck's novella to allow for a more open telling of the story; the narrative can be construed in different sequences and freely explored. Using the user interface structures of early '90s role-playing games—specifically, 3D worlds within 2D illustration—*The Red Pony* expands Verso's navigation methods to the exploration of a narrative contained in the visualization of the novella's setting. Rather than following the text of the story itself, readers enact the protagonist's story. Readers are therefore immersed in several 360 degree illustrated panorama scenes, and may tap on buildings or doorways to move between scenes on the



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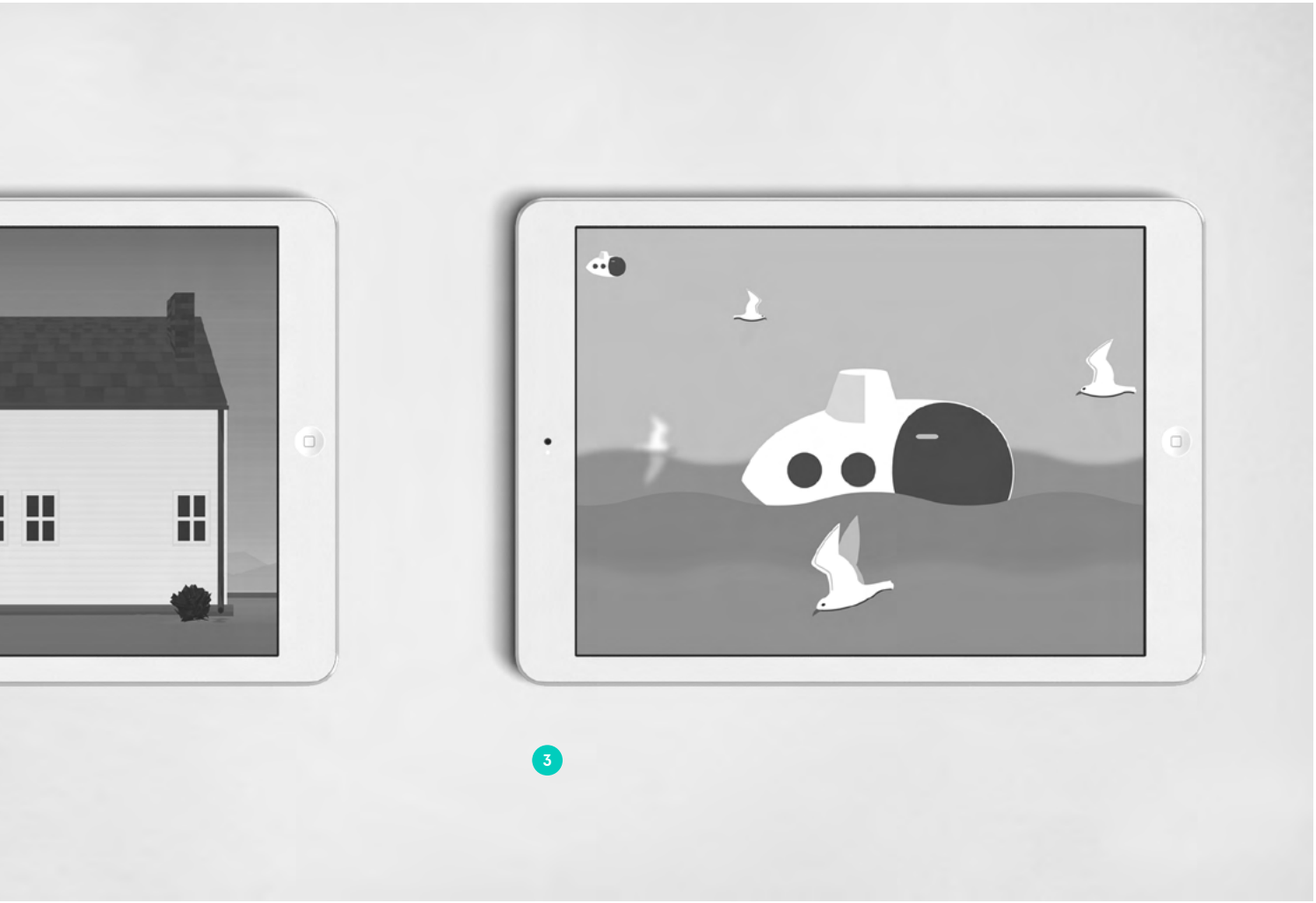
Salinas valley farm. They engage in pre-determined dialogues with the setting's inhabitants as derived from the original text; each conversation has multiple outcomes dependent on a user's selection of pre-determined responses, as well as the order in which the user converses with characters. These multiple outcomes are based on the novella's episodes, and although this fragmentation further disintegrates the linearity of the original novella, it also encourages play and extended engagement as users may wish to repeat the story for all possible endings.

Fish Families (figure 3) uses marine life data compiled from a variety of sources in order to explain and disseminate seahorse, parrotfish, and anglerfish family structures. The interface is divided into navigation and content portions that simulate an x, y, and z axis in order to create a sense of depth and motion further into, through, and past a scene. At a given interval of a dive, they are presented with the seahorse, parrotfish, or anglerfish families and may engage in touch-based interactions that trigger two reactions from the interface. First, the sprites change states in order to illustrate the nature of the family structure. Second, additional textual information is revealed in order to further describe to the reader the marine animals. Through diving and touch interactions, this app promotes exploration and inquisitiveness in an experience based on free play.

DISCUSSION

The three prototypes follow Wigfield and Guthrie's three dimensions of reading (curiosity, desire for challenge, and involvement) with varying degrees of efficacy. These three dimensions of reading measure the success of these prototypes insofar as these dimensions are tied to the intrinsic motivations associated with leisure reading [1]. *Open Closets* presents an interface that calls for early involvement and a completist task that elicits desire for challenge, but may not prolong curiosity in cases where the set of content is limited. *Fish Families* elicits curiosity by virtue of its many animated elements, but doesn't completely harness the full potential for involvement of the x, y, and z axis navigation since it maintained a separation between navigation and content spaces. *The Red Pony* perhaps most effectively responds to these three dimensions of reading, perhaps also due to the reader experience possibilities afforded by fiction. It uses a more complex navigation system than that of *Open Closets* and enables a path of discovery for the reader: a range of choices and results in the story [1]. As such, it perhaps most successfully elicits curiosity owing to its 360 panoramic scenes and interactive elements within said scenes. Like *Fish Families* and *Open Closets,* this prototype presents the challenge of exploring all possible endpoints of the story. In *The Red Pony* the reader is involved in the storytelling process insofar as his or her choices determine the various results of the story.



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CONCLUSION

This paper presented a reflection on the possibilities for alternative navigation patterns and metaphors for a specific 2D physics development toolset. In the process of realizing the prototypes, the designers and developers collaborated with the designers assuming editorial and authorial roles that challenge established publishing practices. The outcomes of the project were too limited in scope (each prototype presented a minimum viable product content scenario) to measure engagement. The objective was to produce qualitative outcomes that focused on playfulness as a form to sustain engagement while exploring alternative navigation structures for industry application. As such, we successfully used the Verso toolset to prototype three unexplored interaction and navigation modes: 1. the use of a stage or field to drag and drop elements and then reveal the next stage of content, 2. the use of panoramic landscapes for free roaming and exploration of content in ways that affect the outcome or tone of the narrative, and 3. the simulated used of a x, y, and z through animation to navigate content from surface to deeper layers.

ACKNOWLEDGEMENTS

Three undergraduate design students at Emily Carr participated in this project: Emanuel Ilagan, Jacquie Shaw and Matthew Pierce. This research was funded by a grant from the Natural Sciences and Engineering Research Council (NSERC) of Canada.

figure 1. *Open Closets Lookbook* uses a paper doll dress-up metaphor to draw connections between members of a communal closet.
figure 2. *The Red Pony* encourages free exploration of the novella's scenes while order and timing of dialogue affect the story's outcomes.
figure 3. *Fish Families* explores the use of depth as a metaphor for advancing from chapter to chapter in this account of ocean animal life.

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Zoë Hardisty

RADIA

Visualizing Code Structures

PROBLEM SPACE

Radia is an immersive visualization tool built to represent the complex data of call graphs. Call graphs are visual representations, generated from binary output, and seen when reverse engineering code. Reverse engineering (RE) is "the process of discovering undocumented internal principles of a piece of code" to "1. enable legacy code to continue to function, 2. identify critical vulnerabilities, 3. understand the true purpose and actions of code" [2].

The problem with current visualization tools is that their format is too limited to express complex data effectively, especially in the commonly used 2D graphs. One of the RE industry's most used disassembler and debugger tools, IDA Pro, recognizes in its graphing tutorial that the visualization "is mainly interesting for small programs, because the graph quickly becomes extremely complex in the case of a program containing a large number of functions" [3]. When the tool's documentation acknowledges the limited functionality of its graphing tool, it truly is indicative of a problem.

Current visualization software places an emphasis on detailed information and labeling to link the data with code blocks. Navigating a graph remains simplistic; it typically uses limited scrolling, selection, and zooming. In short, current graphing tools lack the ability to paint a clear picture of the overall code landscape, and integrate visualization effectively into RE workflows.

The audience for these particular tools are reverse engineers, security researchers, malware analysts and other types of code auditors. In the past, engineers and programmers have been the people to create these visualization solutions; approaching this problem from an interaction design perspective, over an engineering one, allows a shift in focus from the technical details of the code to the usability and relevance of the graphs. Addressing these design issues includes developing the appropriate visual metaphors, creating better interactivity, and improving the ability to parse information.

Within this context, this research project further looks into the potential use of virtual reality (VR) in visualization tools. The research question I am posing is: can immersive VR visualizations of code structures help reverse engineers' understanding?

BACKGROUND

The goal of this project is to build an effective visualization tool, with a user interface (UI) that illustrates potential known problem functions within the code. It will encompass designing and implementing the appropriate UI techniques for travel, navigation, and selection systems within a three dimensional environment.

The use of VR over other methodologies can help reduce distractions while making the code structures more tangible to the user. As the user floats through the code, and as the nodes and connections fill their visual landscape, it becomes more relatable to them both physically and mentally. Current research on immersive visualization has shown correlations to its effectiveness for certain tasks. For example, the benefits of completing the same collection tasks set in an egocentric first person immersive virtual environment (VE), versus an exocentric monitor view, showed that the error rate was lower in VE than on the monitor [1]. This has been shown to be highly effective when looking at interconnected data that contains node and edge structures like network topologies and computer code relations.

DESIGN CONSIDERATIONS

Radia aims to create an interactive and immersive environment that visualizes the symbolic relationships between code and augments the task of reverse engineering binaries. A successful solution will allow integration into the user's RE workflow to reduce discovery time for inputs and outputs, complex parsing routines, calls to unsafe functions, and insight into the typical run-time flow of the application. Navigation and manipulation of the data in the VE should happen in an intuitive and naturalistic way. Lastly, the visual interface of Radia should transform all code markings, interconnections and potential problems in an elegant and meaningful representation.

The visual design of the Radia call graphs uses a colourful set of geometric shapes and coloured directional paths to illustrate specific visual elements in the code and reveal their nature.

This solution breaks the different conceptual levels of the graph into areas with context sensitive controls to alleviate the visual complexity. This, in turn, decreases the cognitive load on the user, so they can focus their attention on discovery as they travel through the graph. Travel and data manipulation is mapped to a keyboard, using the WASD keys paradigm of video games to move through the space.

Manipulation of the code clusters and specific nodes in an unobtrusive UI will show potential problem areas, string references, ingress and egress calls, the number of basic blocks, and allow a space to add linked notes and mark nodes for further review. This is done with context sensitive menus and a minimal overlay display to keep the visual field clear.

CONCLUSION

Data visualization is a difficult task to get right. However, with clear visual metaphors and interaction cues, an immersive environment can help engage the user's spatial reasoning and visual cortex to breakdown information into useful components. Radia is, first and foremost, an information-gathering tool for illustrating interconnections. The likelihood of this interface's success will largely be based on being naturalistic and intuitive to use, allowing users to identify potential problems in the code. In the end, the hope is to improve the available tools for auditing code to readily identify and remediate problems, and ultimately, to make code less vulnerable to exploitation by malware.

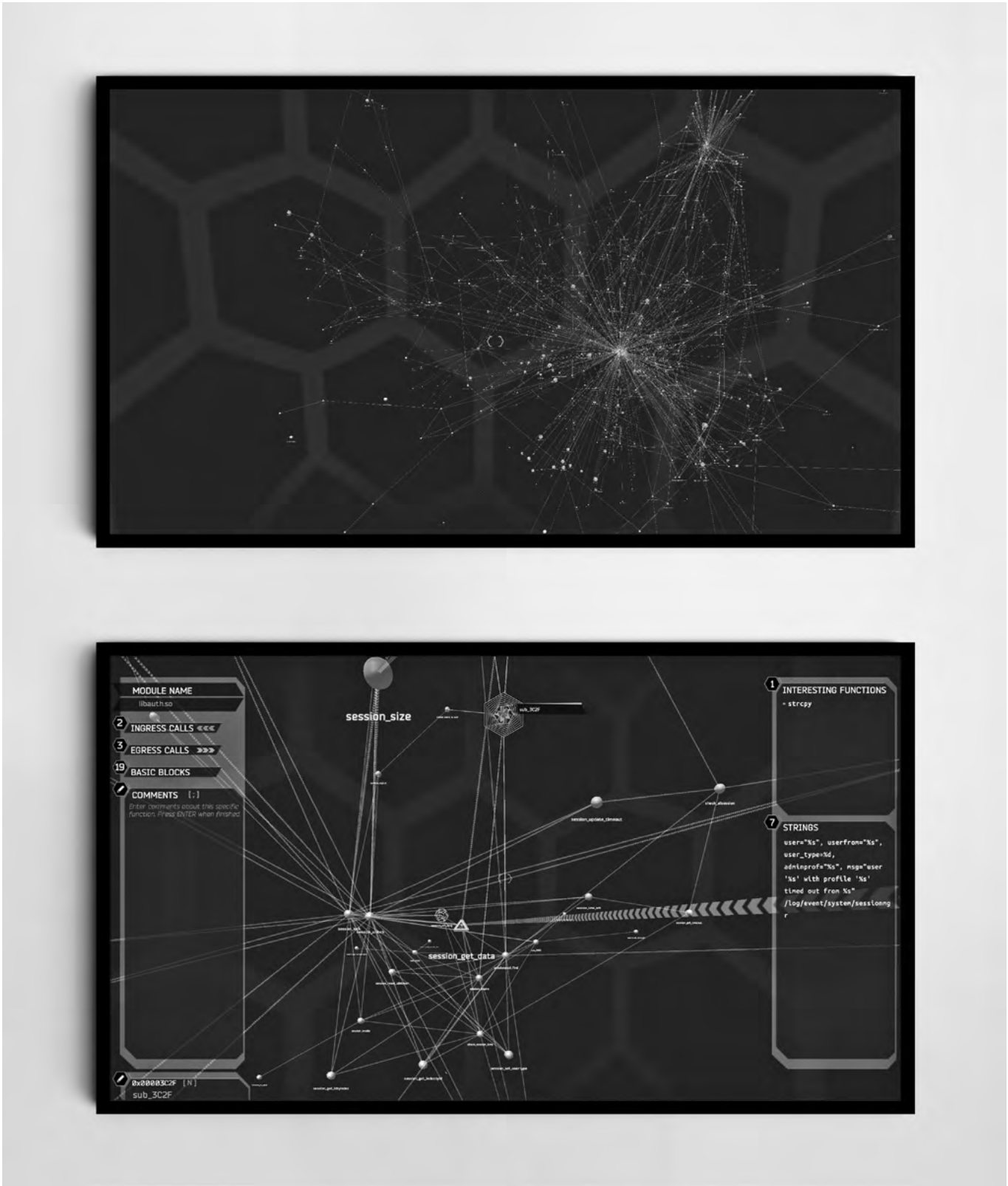

figure 1. Radia is a visualization tool for discovering logical relationships within binary code.

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ACKNOWLEDGEMENTS

Current is the product of many conversations, meetings, hours of writing, editing, and many reviews. We could not have realized this project without the support of Dr. Ron Burnett, Dr. Maria Lantin, Jonathan Aitken and Kate Armstrong of the Research Office; Bonne Zabolotney, Dean of the Faculty of Design and Dynamic Media; Grant Gregson, coordinator of the Teaching & Learning Center; Roxanne Toronto and Cari Bird of Communications; and Tara Wren, copy editor.

The *Current* team would like to thank the students in SOCS 309 F001 and F002 Design Research & Methods for their contributions to issue 06. *Current* is grateful for the support of the Emily Carr President's Research Fund, the Faculty of Design + Dynamic Media through the office of the dean, and our advertisers.

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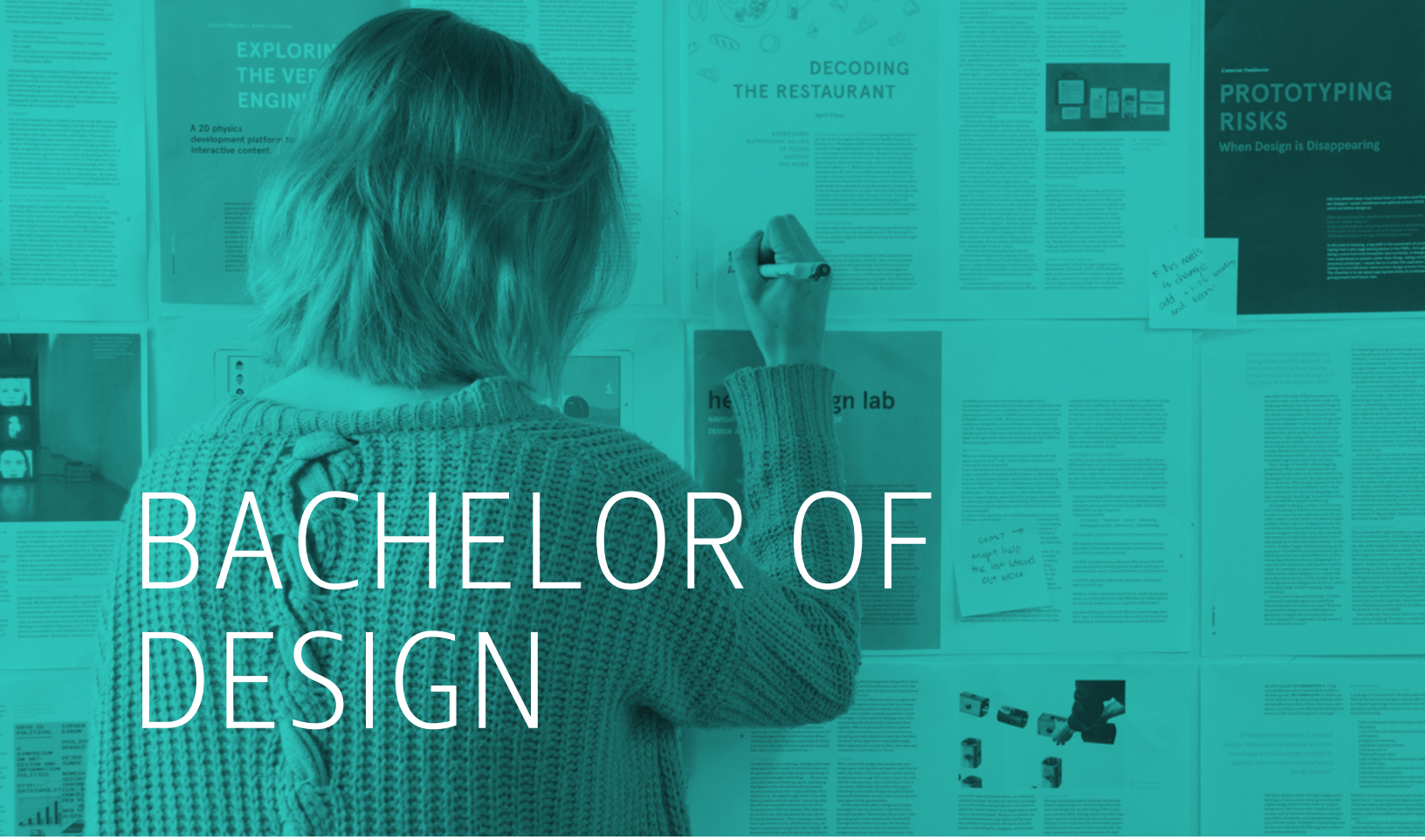

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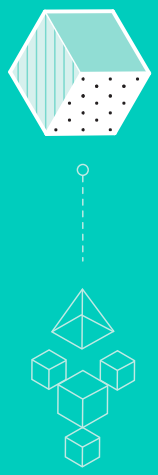

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